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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

DECEMBER 13.

Sheffield Technical Trades Societies:—Ordinary meeting. "Castings for the Giant Cunarder," Paper by Mr. Swift.

Institute of British Foundrymen.

DECEMBER 10.

Scottish Branch (Falkirk Section):—Ordinary meeting. "Odds and Ends of Foundry Plant," Paper by James Arnott.

West Riding of Yorkshire Branch:—Ordinary meeting. "A Few Foundry Problems," Paper by W. Fearnside.

East Midlands Branch:—Ordinary meeting at Derby. "High-Duty Cast Iron," Paper by A. L. Norbury, D.Sc.

DECEMBER 12.

Sheffield and District Branch:—Ordinary meeting. Discussion, "Refractories" (at the invitation of the Sheffield Society of Engineers and Metallurgists).

DECEMBER 15.

Newcastle-upon-Tyne Branch:—Ordinary meeting. "Nitri Cast Iron: Cast Iron suitable for Nitrogen Hardening," Paper by J. E. Hurst.

DECEMBER 17.

Lancashire Branch (Junior Section):—Ordinary meeting. "The Conditions affecting the Behaviour of Carbon in Cast Iron," Paper by E. L. Rhead, M.Sc.

Scottish Branch:—Ordinary meeting. "A Talk on Contraction," Paper by J. Simpson, and "Jobbing Foundry Problems," Paper by J. Wilson.

The New American Specification.—I.

The British foundryman will be aware of the standard American bar which was in existence until recent years. Known as the arbitration bar, it was originally 1¼ in. dia. and tested at 12-in. centres, the condition of moulding and running being specified. Recently this bar was reduced to 1.2 in. in dia. and arranged for testing at 18-in. centres in conformity with the British medium size bar, and an approach was made to dealing with the problem of castings of different thicknesses by specifying different loads for which the same test-bar could be used, the stronger material, representing the thinner section, naturally bearing the greater load.

The new specifications adopted at the June meeting of the American Society for Testing Materials will be read in this country with particular interest, for they indicate that informed metallurgical opinion in the United States has adopted the British method of specification. It is sufficient for the moment to say that three bars are specified: 0.875-in. bar tested at 12-in. centres, 1.2-in. bar tested at 18-in. centres, 2-in. bar tested at 24-in. centres. Since these specifications must have been based on a great deal of experience and actual tests, they form a striking vindication of the method of testing given for the first time in B.S.I. specification 321, 1928. Not only is this the case, but they will afford valuable support to those who believe that a casting is best characterised and tested for acceptance purposes by a separately-cast bar. Naturally the specifications of the two countries are not similar in all points of detail, but they are certainly based on the same metallurgical approach.

The main tests specified are transverse and tensile. The transverse tests are made on the bar as cast, and corrections are provided for over-sized or under-sized bars. Tensile and transverse test-bars are cast separately from the casting, or, optionally, transverse test-pieces may be machined from the broken transverse bars. The test-bar sizes have already been mentioned; the smallest bar, 0.875 in., is for castings of a controlling section up to 0.75 in. maximum. The 1.2-in. bar is similarly intended for castings of controlling section 1.1 in. maximum, and the 2-in. bar for castings of controlling section 2 in. maximum.

Debates Not Wanted.

There have recently been held several debates on the subject of castings versus weldings, and one of these we publish this week. We have reached the conclusion that it is a wrong policy for scientific institutes to stage full-dress debates on technical subjects, as such efforts are liable to detract from clear scientific thinking. By using the arts and subtleties of debate, the better speaker can make minor matters appear to be of cardinal importance. The proper place to determine the intrinsic worth of competing industrial developments is in the quiet of one's own office. The best way to secure the most reliable information is to study Papers presented to scientific associations and contributions to the technical Press. The former, when properly discussed in an atmosphere free from "point making," will produce data of real scientific and industrial worth. This has been amply demonstrated by many decades of useful work conducted by the various engineering metallurgical institutes. Moreover, we think that the public would get a better appreciation of politics, if their various aspects were presented in the form of addresses free from the showmanship inseparable from debates. The use of debate is to allow speakers to acquire fluency in expression and quick thinking. Neither of these is an essential in the presentation of scientific data. We admit that comparatively recently we advocated the introduction of debating as a means of overcoming inarticulation inherent in some technicians which is liable to cause loss to the value of many Papers presented. As a result of further experience, we would leave this to societies specially created for the purpose of furthering the art of debate. For the advancement of the engineering and metallurgical sciences, it is not so much how one says a thing but what one says. The various technical institutes have done very well without any atmosphere of the debating society, and we depreciate for the sake of scientific progress any attempt to introduce it.

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Outlook for Scrap.

By "Onlooker."

Demand for scrap metals at the present time may be said to be well below normal, and yet the large number of dealers in old metals in this country all seem to be able to "scratch a living." In this connection it must be remembered that since the war there has been a very considerable increase in the personnel of the scrap-metal trade, and such business as is available must therefore be divided among many more than was the case twenty years ago. In estimating the spheres of activity of the various firms and individuals engaged it must be remembered that there is a "second line," *i.e.*, a group of houses that do not sell direct to consumers but confine their activities to transactions with their *confrères* in the same line of business. If one considers that to-day the trades consuming old metals are certainly not very busy, one is forced to the conclusion that dealers are being compelled, as it were, "to take in each other's washing"!

Parcels of scrap do, as a matter of fact, frequently pass through many hands before finally coming to rest in a foundry, and some of the shortweights and other troubles frequently connected with the purchase of old metal must be attributed to this fact. Consumers may and do sidetrack the dealer by going direct to the fountain head and purchasing from the railways, the shipbreakers and the Government departments, but as a rule they prefer to make their bargain with a private trader rather than with the "producer" of the material, as there is usually a better chance of obtaining satisfaction in the event of any difficulty. This is particularly the case to-day, when the call for scrap is below normal, and in many instances the metal merchant is finding that his purchases have to be financed for some time before they can be disposed of. In many cases the original holder of the scrap would prefer to deal direct with actual users, since a middleman's profit is thereby eliminated, but to do this means carrying large stocks, for whereas the merchant is always a buyer at a price, the manufacturer comes into the market only spasmodically and often with timidity.

The Export Market.

On the home market to-day trade is certainly not brisk, but scrap dealers report a steady demand from the Continent, particularly from France and Germany, who, owing to the external value of the £ being down to about 13s., can afford to pay what in this country are really favourable prices for brass and copper scrap. Much of the material disposed of in this way is of the lower-grade class, and a big business is passing in brass swarf, of which fair quantities are available at those factories turning out small parts and sections. Germany, with her growing production of copper, is always on the look out for material suitable for smelting, and as a result good prices are obtainable for copper bearing residues c.i.f. Hamburg, the freight from London being, of course, low by comparison with rail rates in this country. That all this material should be leaving our shores is satisfactory from the point of view of export trade, but perhaps less pleasing when considered in the light of possible future requirements by users here.

With better trade, however, will come improving prices, and these in turn will doubtless bring about the release of material which is at present held back by some of the big houses, who, rather than cut a loss, prefer to await events and hope for an upward swing in commodity values. Although users are complaining that the quotations of old metals have not been brought down in proportion to the decline in virgin metals, there is no doubt that the poor return realised by shipbreakers and others to-day is reducing the turnover in the trade.

Legal.

AUSTIN MOTOR COMPANY'S MECHANISED FOUNDRY.

An action by A. J. Brandt, Incorporated, of Detroit, against the Austin Motor Company, Limited, of Longbridge Works, Northfield, Birmingham, to recover £3,060 balance due for services rendered, came before Mr. Justice Macnaghten, in the King's Bench Division, on Thursday, December 1. Defendants, who had already paid plaintiffs more than £15,000, admitted the claim, subject to set-off and a counter-claim for more than £40,000.

Mr. A. T. Miller, K.C. (for the Austin Company), opening the counter-claim, said that the dispute arose over the employment of plaintiffs, who were experts in engineering lay-out, to reorganise the defendants' foundry, and the issue was whether there had been a warranty by plaintiffs to achieve the results they promised, a saving of £16,216 a year, or whether plaintiffs were merely expressing a pious hope that they could do this. The position was that the Austin Motor Company had spent more than £40,000 on the scheme, and the results had been deplorable. There was another issue between the parties as to whether due expert skill had been exercised by plaintiffs, but that was the subject of other proceedings.

The gist of the matter was that plaintiffs, having made an examination of defendants' works, and having been given the fullest facilities and information, made a report in July, 1930, on the foundry, and the case for defendants was that plaintiffs expressly said that if they were employed to do the work, and the Austin Motor Company would spend £40,000 upon it, the latter would save £16,216 a year—a return of 40 per cent. on their expenditure. The Austin Motor Company had spent some £43,000 on the scheme, apart from more than £18,000 paid, or to be paid, as fees, etc., to plaintiffs.

Mr. J. Morriss (for plaintiffs), in reply, submitted that it was an amazing proposition that his clients for a sum of £18,000 should have entered into a solemn bargain that the Austin Motor Company should effect a saving of £16,216 a year for ever. Counsel said the success of the scheme depended on the co-operation of the Austin Motor Company's employees. Plaintiffs honestly believed that a saving of £16,216 a year could be effected, but there was nothing in the way of a firm contract or warranty.

Judgment in the case was delivered on Monday. Mr. Justice Macnaghten explained that the matter came before him on an order of Mr. Justice Swift as to preliminary issues to be tried. The issues related to the counterclaim and were:—(1) Was there a warranty that the scheme could be carried out for £40,000 and would result in a saving of 40 per cent. of the defendant's investment, or £16,216 per annum, and (2) was there a warranty that the scheme would be carried out in accordance with a definite schedule in sixteen weeks. Mr. Justice Swift's order further provided that if these issues were determined for the plaintiffs, judgment would be for them, with costs; if judgment was for Messrs. Austin there would have to be further direction on the questions whether any warranty was broken, and what were the damages.

Mr. Brandt went to Birmingham after he had visited works of reorganisation which his firm were carrying out in Russia, and Sir Herbert Austin asked for "a definite estimate of economies you can promise" at Longbridge, and of expense and time. Mr. Brandt wrote: "The labour cost of your product is double what it should be; I am confident there is no place in your operations where the capital expenditure necessary would not be returned to you in two years or less." The work was not done in 16 weeks. When the plaintiffs wrote of "the contract date of completion," they said that was only a hope, in the sense that unexpected obstructions must be taken into account. In the same way they said that what were called warranties of saving were expressions of opinion. What impressed him, the judge continued, was that Brandts were not going to do anything to improve Austin motor cars; they were going to reorganise the works so that cars could be produced at less cost. That must carry legal obligation in a scheme to cost £40,000, with £18,000 payment to the plaintiffs in addition for their services. It would be remarkable if the plaintiffs were to enter into a scheme with obligations as to time and cost, and get no obligation as to what the result of the whole expenditure should be. Messrs. Austin declared that instead of a saving they were worse off than they were before, and so far from halving the labour bill, the result of the reorganisation was to increase it. It would be odd, if that was the result, that the defendants could be involved in paying £58,000, and yet could have no remedy. He must enter judgment for the defendants on these preliminaries, and the costs of these preliminaries would be reserved to the next stage of the trial.

The issues would be answered in favour of Messrs. Austin. He found that the true contract was that the plaintiffs agreed that, if they were employed, they would warrant that the reorganisation cost would be £40,000, that the work would be done in 16 weeks, and that the result would be the saving indicated in the report. It followed, on the terms of Mr. Justice Swift's order, that now there must be further direction as to whether any warranty was broken and what were the further obligations and rights of the parties. Counsel might be able to agree on a form of order.

It was intimated that counsel would consult together and that they might be able to agree so as to end the whole matter.

Domestic Engineering Joint Conference.

At the invitation of employees in the heating, ventilating and domestic engineering industries, employers have been meeting them during the past three months in an endeavour to solve, by common effort, problems arising out of business depression. Relations of masters and men in these industries have always been notable for unusual cordiality. Consequently the approach of the men was welcomed and steps were taken immediately to appoint delegates from both parties. First of all, difficulties were tabled, recommendations were made, branches throughout the country consulted, their opinion laid before the main conference, and, in most cases, solutions satisfactory to both sides agreed upon.

The scope of the deliberations included not only wages and hours of labour, but the question of apprenticeship, suggested alterations in the system of promotion from the lesser skilled ranks of employees, the observance of rules relating to working conditions throughout the country, the employment wherever possible of local labour and the severe competition with which industry is faced. In view of the latter, the advisability of launching a scheme of propaganda was considered, and it was felt by the representatives of the operatives' union that, as the union was interested in the development of the industry in the same way as the employers, they would like to consider whether they could make some contribution towards the cost in the event of such a campaign being carried out.

Publication Received.

Specifications and Methods of Test for Refractory Materials and Manual for Interpretation of Refractory Test Data. Prepared by Committee C 8 on Refractories and published by the American Society for Testing Materials, 1315, Spruce Street, Philadelphia, Pa. Price 50 cents.

The first part of this work is devoted to reprinting the A.S.T.M. standard specifications for fireclay bricks for (1) the bungs for the removable tops used in connection with malleable melting furnaces and annealing ovens, (2) for stationary boilers and (3) marine boilers. This is followed by the standard methods used in America for testing the properties of refractories in general except sands. Then come two tentative methods relating to spalling and particle size for plastic refractories. The Committee has wisely included a number of standard and tentative definitions. The final section, which occupies about 30 pages, is a manual for interpreting the data derived from tests on refractory materials. This constitutes the most interesting section from the British point of view, and is well worth close study by all users of refractory materials.

Fabricated Parts *v.* Cast Iron.

One of the most interesting meetings in the history of the West Yorkshire branch of the Institute of British Foundrymen was that at Bradford Technical College, on November 12, when a debate took place on the respective merits of cast iron and fabricated parts. Mr. A. S. Worcester (Huddersfield) presided over an excellent attendance, which included Dr. H. W. Swift, head of the Engineering Department of the Technical College, and several visitors interested in electric welding.

The debate was opened by Messrs. E. B. Shore, who spoke on fabricated structure, and replied to by Mr. A. W. Walker, who dealt with iron castings. The two gentlemen are colleagues in the works of Messrs. Thos. Broadbent & Sons, Limited, Central Ironworks, Huddersfield.

FABRICATED PARTS (Mr. Shore).

Welding, as a commercial proposition, has undoubtedly come to stay, and the duty of technologists is to keep their minds active and always be on the *qui vive* for new developments even if they are prejudiced to some extent against them. At the moment there seem to be only two things that are of any consequence—delivery of a job and its lowest cost.

About 30 years ago the reputation of any particular firm for its own particular product was sufficient for the order to be placed, and the firm given a reasonable time in which to complete the job.

At the present time, reputation does not count for as much as it did; the things that matter are, as stated, quick delivery and lowest price. Therefore, when an order is given there does not seem to be sufficient time for the carrying out of the various methods of manufacture that we considered necessary in the old days, and therefore it is necessary to look for new methods which will give the same efficiency as before, together with greater speeds, and one of them is welding.

Periods of economic and trade depression are generally marked by an extension of those production methods which result in a lowering of the cost of manufacture, and if such methods produce in the end a better article the process becomes a permanent one. Prominent amongst the various processes which have come to the front during the last few years is electric welding, especially the metallic arc section, which the speaker proposed to stress. All welding has been and still is the subject of much criticism from various people, and the remarks used generally assert that so much depends on the human element. Yet so does everything else. Or, again, if it is stated that welding depends entirely on the operator, it can be answered by an equally strong assertion "so does everything else."

Such remarks are futile and not helpful. It is preferable to hear the remark "show what can be done and it will be judged on its merits." Having extensive experience during the last twelve or fourteen years in all kinds of welding, including mild steel, cast iron, monel metal, stainless and Staybrite steels, copper and various alloys, and from that experience and also from following the new era of fabricated products in mild steel, to replace castings made from either cast iron or steel, it is a personal feeling that in quite 60 per cent. of cases where cast iron is now used, arc-welded steel would be better and cheaper.

Ornamental cast-iron poles, which were universal when electric trams came into being, have practically disappeared, and have been replaced by steel tubes, which are obviously much more economical. It is postulated that in a comparatively short period large electric motors with cast-iron frames will be as obsolete as a cast-iron pole. The fabrications to be mentioned must of necessity be a small number compared with the great number that are made. Some of the principal ones are bed plates and foundation plates for portable or semi-portable machines. With these there is no fear of breakages due to faulty handling or carelessness of the operator.

The advantages to be derived from fabricated parts are very numerous. For instance, no patterns are required and incidentally no storage for them; no moulding boxes are required, and the numerous difficulties the iron founder encounters, especially during the winter months, are eliminated. Also any alterations, when designs have been tested, can be carried out quite easily with a fabricated structure, whilst as to weights and strengths it is claimed that steel is stronger than cast iron in compression. Tables of strength of materials give the compressive strength of cast iron as 90,000 lbs. per sq. in. and the compressive strength of steel as 70,000 lbs. per sq. in. This apparently indicates that cast iron is stronger than steel in compression.

Factors of Safety.

Let us examine the facts more closely. The figures cited do not represent the safe working limits, but represent the ultimate or breaking stress. Naturally in practice, metal is not stressed to the breaking point. The maximum allowable stress beyond which it is unsafe to go is found by dividing the ultimate strength, by a number called the factor of safety.

Sound engineering practice stipulates the factors of safety for cast iron and steel under various kinds of load, as set out in Table I.

TABLE I.—*Relative Factors of Safety for Steel and Cast Iron.*

Material.	Load.	Factor of Safety	Mx. S. lbs./sq. in.
C. I.	Steady	6	15,000
C. I.	Varying	10	9,000
C. I.	Shock	20	4,500
Steel	Steady	4	17.500
Steel	Varying	6	11.300
Steel	Shock	10	7.00

Relative Weights of C.I. and Fabricated Bedplates.

In this connection it is insisted that the weight when made in steel can be cut down by as much as 15 to 20 per cent. in a small bedplate and 25 to 40 per cent. in a large one. This can be done with the discreet use of stiffeners and gussets welded rigidly in the correct place, and will produce as rigid a structure as any casting can give, with the minimum amount of metal. In a casting it seems to be a regular practice to put heavy masses of metal to get strength, or to deepen the casting so as to get a massive box or H section, whilst in fabrication bends, angles and joists of light section can be easily utilised. Moreover the stock yard will not have to be of very large dimensions, to house comfortably, all sections necessary to fabricate parts of medium and large size, to equal the output of a fairly large foundry.

Heavier Fabrications.

Typical of this is an all-steel welded frame of a 15,000-h.p. alternator, driven by a water turbine at 750 r.p.m. To give an idea of the size of this fabrication, the alternator when complete weighed 75 tons. In the United States arc welding is universally used, and they are much more advanced than Britain, owing perhaps to British conservatism, which is difficult to overcome.

There are just as great developments to be obtained from electric arc and other forms of welding as has accrued from the changes to steam and petrol power in land and sea transport. They are awaiting development by the manufacturer who will study their possibilities with an open mind and a firm determination to apply it to his own products.

When a fresh type of casting is required days are spent on the drawing board, and in the patternshop, whilst still more days are taken up in the foundry, and when all this is done, if the model is not satisfactory, the whole process must be repeated. Contrast such a proceeding with a fabrication. Rough sketches can go direct from engineering to welding shop, patterns are unnecessary, actual working models can often be put together in a few days' time, and alterations can be easily made with the use of an acetylene cutter and re-welded by the arc process.

If this can be done with a new design, how easily it can be carried out in production. It thus behoves every iron founder to be on the alert, and ensure that welding is a part of his plant. The organisation has not yet been found that can estimate exactly the number of any given model that will be built, nor even the number of parts of each kind that are needed for a given production, and so it comes about that with the discontinuance of certain designs there are left many hundreds of obsolete castings, which at best can only be priced at scrap value. Such waste has been almost entirely eliminated, in plants where welding is used to its best advantage.

Finally one thing the modern foundryman will have to do, and that is to obtain all the knowledge possible about welding, so that when moulding and welding become universal, as they surely will, he will be ready and will cast what is best for casting and fabricate by welding those parts which will give him a greater profit, and incidentally a greater percentage of fabricated parts as against castings.

IRON CASTINGS (Mr. Walker).

Modern demands for higher duty materials, combined with the development in the manufacture of welded structures, have certainly given foundrymen a most serious competitor from an unexpected quarter. Probably the presence of this permanent rival will do what research has failed to do, *i.e.*, awaken the foundryman to the fact that his material will have to be considerably improved. The engineer has for many years been demanding materials suitable for withstanding higher stresses, and the slow acceleration of the foundryman in meeting these demands has been taken advantage of, by the fabricated article manufacturer. It is hoped that the foundryman, now that he realises how serious is this competition, will make greater urge to improve the quality and reliability of his products. The scarcity of skilled moulders of the highest grade no doubt was another tributary cause helping the evolution of the fabricated article.

As a case in point, a large electrical firm in this country followed the lead of America five years ago, and made large stator-frames in welded steel simply because the foundry produced so many wasters in making these frames in cast iron. The foundry *can* produce *quality* castings. As a matter of fact, the adjective quality should not be required. The word casting should be enough to infer the rest. Where a scarcity of really skilled moulders is found, modern methods should be adopted, so that the lesser-skilled workman is enabled to produce castings of the *quality* brand. This enables the higher skilled craftsman to devote his ability to more complicated work. The foundryman, if he will, can improve his material to such an extent that he can advise the designer to lighten his sections, substitute ribs for mass, and so lighten the total weight of the component, that transport charges will not be so much in favour of the lighter-sectioned steel article. To do this he will have to think in terms of 16 tons tensile and over, instead of 12 tons. The

former material can be produced just as cheaply as the latter.

There is no doubt that the lack of faith the foundryman has in his products gives the engineer a sense of distrust in iron castings. The foundryman notably suffers from an inferiority complex. He *has* lagged behind. Notwithstanding the mass of published data from metallurgical research, the evidence of the result of scientific co-operation, his methods have remained largely empirical. If the lead given had been intelligently followed they need not have feared any competitor, either fabricated article at home or foundries abroad.

Pertinent Questions.

The disadvantages of castings has been experienced for so many centuries that people are often apt to overlook the advantages, particularly with iron castings. On the other hand, they have not had much time to find out the advantages or disadvantages of welding. The following questions come to the mind of the foundryman when he considers welded structures:—

(1) Are they rigid? In the case of a large frame or bed, is it necessary to use a large number of cross ribs, etc., in order to maintain freedom from distortion? Cases are known where weldings, after machining, have been found to be sprung. Can this be prevented? If so, at what extra cost?

(2) Are there any authoritative data as to the effect of the welding process upon the neighbouring material? To what extent is distortion experienced due to the welding process?

(3) Is the metal in the finished weld homogeneous? Is it the case that welded steel shows zones of varying structure, the carbon content being widely different at adjacent zones? If so, will such zones have different physical properties, such as thermal expansion, hardness, strength?

(4) How can a bad weld be distinguished from a sound weld? If a bad weld be experienced, is this largely due to the personal factor or present incomplete state of the art?

(5) What reduction of fatigue strength will be experienced on welded joints containing slight slag inclusions?

(6) How does the factor of vibration affect a machine tool for precision production? Also what effect has the factor of vibration on the crystallisation of the parts heated during welding?

Advantages of Grey Iron Castings.

On the other hand engineers are often inclined to overlook the following properties of castings in merely considering what the engineer considers the only property of cast iron, that is cheapness.

(1) *Rigidity.*—The rigidity of cast iron is undoubted an inherent quality experienced in no greater degree in any other metal. The word cast iron is a current phrase in our language. There is no danger of distortion with cast-iron structures as cast iron will break before it will bend. This is a most important factor in the manufacture of engine-bed frames, machine tool parts, etc.

(2) *Uniformity.*—A well-made casting is uniform in structure throughout. There is no sudden change in structure, due to local heating.

(3) *Toughness.*—High duty cast irons are being made to-day possessing a good measure of toughness. They are not so brittle as the more common type of cast iron, and while they still retain this remarkable quality or rigidity they will stand up to shock in a remarkable manner.

(4) *Corrosion Resistance.*—The resistance to corrosion under atmospheric conditions is a very valuable property of cast iron. Also, under more variable conditions cast iron's corrosive resistance has been exemplified. For instance, the scrap from a cast-iron bridge, which had been subject to the rise and fall of tides for over 80 years. On examination the surface of the metal was not pitted above ¼ in. at the most. This was an exceptionally severe test, representing an extended dipping and drying corrosive test. A steel structure under these conditions would only have been preserved by repeated and costly coverings of an anti-rust preparation. This point is worth consideration. What will be the cost of preserving fabricated articles? If they are to give the life of a cast-iron counterpart the expense will be considerable.

(5) Castings have a better creep strength than wrought material. That is, at high temperatures and under load, the amount of creep or deformation is less with a cast structure.

(6) *Compression.*—Values of the ultimate strength of metals in compression are somewhat vague, for the reason, in the case of the more ductile metals, that they do not fail suddenly and completely as in tension, but submit to compression after they are deformed, and in the case of brittle metals because of the peculiar way in which they break off at an angle. For example, structural plates have an elastic strength of about 40,000 lbs. per sq. in., but under compression will deform above this figure, although much greater load can still be applied. Cast iron will withstand a load under compression of from 80,000 lbs. to 100,000 lbs. without deformation, but will suddenly fail. The figure at failure representing the ultimate strength. It is easy in discussion to confuse the elastic strength of the softer metal with the ultimate strength of cast iron, but the values are vague.

(7) *Fatigue Strength.*—The failure of engineering components under repeated or vibrated stresses is known as fatigue. The maximum stress to which a material can be subjected without failure is known as the "fatigue" or "endurance" limit. For cast iron the values of the endurance limit are:—

Poor cast iron, 4 tons per sq. in.
Medium cast iron, 6 tons per sq. in.
Good cast iron, 8 tons per sq. in.

It will thus be seen that cast iron can be repeatedly stressed up to about one half its tensile strength without risk of fatigue failure. One large firm of machine-tool makers in this district design their machines to much higher stress conditions than those just quoted, viz., 1.25 tons to each 2 tons tensile, and no failure from fatigue has ever resulted. For fabricated components, they find that they have to allow a 66 per cent. margin on physical strengths. In addition it is known that the presence of notches or sharp corners in steel is liable to cause fatigue failure, owing to the concentration of stresses at the notches. The presence of such notches in steel definitely reduces the endurance limits. It has been proved without doubt that with cast iron the influence of such notches on the endurance limit is almost negligible. This is because the graphite flakes in a cast iron act as stress raisers and reduce the endurance limit in the first place, so that the addition of notches has no further influence. This is very valuable when castings are subjected to vibrational stresses. On the other hand, it should be remembered that with welded structures, there is always a possibility of hair cracks and slight irregularities which may form the starting point for a fatigue crack.

(8) *Wear Resistances.*—The wear-resisting qualities of cast iron are a valuable property which has been made full use of by engineers. In steel this property is usually obtained by heat-treatment, and this cannot be applied to large or complicated fabricated articles with risk of distortion.

Damage in Transport.

The arguments for fabricated articles, as being less likely to suffer damage during transport, are quite sound in their way. However, as insurance companies' statistics show, the liability of a cast-iron component suffering reparable damage is only 1 in 1,400, and total destruction losses are three or four times these figures, the idea of substituting a fabricated article for a cast-iron part because of its greater safety in transport is, in the face of facts, not worth while. Fabricated articles are certainly lighter, but lightness of section is very often a mixed blessing, and in some cases not an advantage. Where the part is a component of, or is a full machine, that has any tendency to vibration, the exaggerated noise of running gears is considerable. When the machine is one for duty, *e.g.*, a shearing or punching machine, light-steel sections cannot be employed, as weight of the base is essential. The custom is to use heavy armour plate of a section approximating to that used on a like machine of cast iron. A designer of this class of machine informs me that the replacement of punches on a 1-in. punch of the fabricated type is many times that of a cast-iron machine. This is due to the excessive vibratory factor met with in the fabricated machine.

The jobbing foundry really need not fear the new competition. From a skeleton pattern or a set of strickles which can be produced at little cost, a casting can be produced which will be much less costly than the fabricated article. Comparison is made by the welder as to the cost and multiplicity of patterns compared with the cost of the welders' requirements. Probably the foundry has been placed at a disadvantage in this respect. If the foundry is asked to produce work of a repetition character, this pattern expense and pattern multiplicity disappears. It is only when the work is of a varied character that the pattern multiplicity occurs. On jobs of a repetition character the foundry probably has the advantage, as the templates, press blocks, etc., required by the welder represent the expenditure of a great deal of labour and capital. It is very much a matter of conjecture whether a pattern or a press block occupies the more space. In the initial stage drawings are required for each, and any well found firm will insist on these drawings being such that the record of the manufacture will be quite clear. A rough drawing or sketch may get a job made once under one supervisor, but a good drawing will get a job made under a change of supervision, and changes occur from various causes. Lecturers on fabricated articles often hold out the sop to the foundryman that he should incorporate the new art. There is no link for this alliance. A new race of foundrymen will have to appear, being different in training and in thought. The foundryman would imagine he was in Valhalla if he had to contend with a ready-made homogeneous material. It can be pointed out that steel founders are equipped with welding plants. The case is, however, quite different. The art of fabricating articles is not the art of filling holes. It is something which has made a most remarkable advance, having its own particular technique, and will as it ages accumulate its own traditions, and those traditions will be very different from our own.

Foundrymen have to give all praise to the welder for his courage and his width of vision in embarking and making successful the manufacture of fabricated articles. In the first place, he was short of data, and his experienced welders were scarce. He was most unfortunate, however, in choosing a name for his new baby. Why he ever chose the name "fabricated" as an industrial designation will probably never be known. The dictionary, among other definitions, tells us that fabricate is to devise falsely.

Prof. Charles Inglis, Professor of Mechanism and Applied Mechanics at the University of Cambridge, is reported to have said that the use of iron and steel, except for the manufacture of motors and dynamos, will soon be a thing of the past. He contends that chemists and scientists are making such rapid progress in research work that they are discovering new and better materials. Having tested the tensile strength of a spider's filament, and found it to be 500 tons per sq. in., he says that with such material to replace steel cables the English Channel could be bridged with a single span.

Fuel Oil in the Foundry.

SUCCESSFUL APPLICATIONS.

Mr. T. F. Unwin's Paper, which has appeared in recent issues, gave rise to an interesting discussion. It was opened by MR. SMEETON, who said that all who had listened to the lecture must have been impressed by the claims made for oil-fired furnaces, which, if they were all substantiated, would point to a simple and economical solution of many foundry problems. He asked for some further explanation on several matters, one of which was the length of flame possible from oil burners. The illustrations shown by the author seemed to indicate that the combustion took place very close to the end of the nozzle. In many furnaces there was needed a continuous flame, giving off a regular amount of heat throughout the whole length of the furnace. This could be achieved by controlled and deferred delivery of secondary combustion air in various types of gas and powdered-fuel furnaces, and it would be interesting to know whether, in an oil-fired furnace, the length of the flame and the temperature in the various parts of the furnace varied with the pressure at the nozzle.

Another matter was whether the oil flame had a serious oxidising effect. In various types of gas and powdered-coal furnaces there was considerable oxidation, owing to excess of combustion air, and this was one of the most important features in heating or melting ferrous metals. Therefore, he asked what degree of oxidation resulted from oil flames as compared with gas or powdered-coal flames, whether the latter be powdered or solid coal.

Again, Mr. Smeeton asked for information as to the life of the linings, particularly in rotary cast-iron-melting furnaces of the Stein or other similar types, because in his experience that constituted one of the greatest problems in working costs. Mr. Unwin had intimated that linings in non-ferrous metal-melting furnaces would stand hundreds of heats, but he had refrained from stating the number of heats which the linings in Stein or other types of rotary oil-fired cast-iron-melting furnaces would stand. He (Mr. Smeeton) had carried out investigations with the Sesci and other similar types of furnace, and had found that the linings would give from 70 to 100 heats, according to the temperatures attained and the type of iron melted. He asked what number of heats was claimed in an oil-fired furnace of similar construction.

With regard to vitreous enamelling, he asked what quantity of oil fuel was used, at a temperature of, say, 700 deg. C. per sq. ft. of enamelled surface or per ton of castings enamelled. That seemed to be a most important feature.

Finally, Mr. Smeeton said that the lecture had been most illuminating, and even if only 75 per cent. of the claims made were true, there were many possibilities opened up to those who were considering a change from the cupola to other more modern types of melting plant, fired by means of powdered fuel or oil.

The CHAIRMAN (Mr. V. C. Faulkner) discussing the composition of steel made in the Stein furnace, said there was a pick-up of 0.4 per cent. phosphorus, which was ascribed to the scrap used. It was perfectly clear that if the Stein or other furnace were used habitually for the making of cast iron and it was suddenly switched over to the making of steel one must expect a pick-up of phosphorus such as had been indicated by Mr. Unwin.

MR. V. DELPORT asked for information concerning oil-fired cupolas, and recalled that a recent article in a Continental review had described such a cupola; it was claimed that it produced better metal than the ordinary coke-fired cupola, though the cost of the fuel per ton of metal produced in the oil-fired cupola was higher than that in the coke-fired cupola. On the other hand, a number of economies were claimed for the oil-fired cupola, resulting from less handling and the use of scrap—as much as 80 per cent. scrap could be used. It was stated that the users began to obtain liquid metal about 20 min. after the burner had been started.

Results from Practice.

MR. BLACKWELL said that his firm used about 10,000 galls. of oil fuel per week throughout the year, though none of it was used for metal melting. It was used for melting enamels in the rotary furnaces; for firing a battery of vitreous enamelling muffles and for firing the Cornish boiler, which was used for heating tanks, plating baths, and so on. Before oil firing was adopted it had been the practice to use the ordinary boiler coal in the Cornish boiler, and gas coke in the enamel-melting furnaces and in the enamelling muffles. There was a battery of 7 muffles, 15 ft. long, all oil fired. The economy resulting from the change from solid fuel to oil fuel had proved that the change was well worth while. If solid fuel were used to-day instead of oil, it would be necessary to employ three men wholly on unloading coke into the store yard, three men handling it from there, and a number of men shifting the ashes, and, of course, there would be the usual carting of the ashes from the dump. All that, however, had been dispensed with, and under present conditions one man looked after the whole of the burners on the muffles and the Cornish boiler. Thus, in respect of man-power, there had been a considerable reduction. The oil was stored in old Lancashire boilers alongside the railway line; it was delivered in fuel tankers by the oil company and was pumped direct from the tankers to the storage tanks. The man who looked after the oil burners also attended to the emptying of the incoming tankers.

The length of flame from an oil burner was important to his firm, because they must have a uniform temperature throughout the whole length of the muffle. Otherwise, on steel plates or castings, the enamels would come out a variety of colours, and a lady who wanted to buy an enamelled article would decline to accept one in which the colours were not matched.

There were some factors with regard to oil which Mr. Unwin had carefully refrained from mentioning. For example, the sulphur content of the oil used in enamelling plant was a very important matter. If sulphur entered the muffle, everything in it would have to be scrapped, so that it was essential to purchase an oil having the very lowest possible sulphur content. The risk of fire from oil in a properly erected installation was practically nil, and there was no increase of insurance rates by reason of the storing of something like 30,000 or 40,000 galls. of oil at a time. The burner could be fitted with an automatic cut-out which would operate in the event of the electric power failing, so that the oil supply would be cut off immediately, and there was no fear of the oil catching fire.

There was not the slightest doubt that his firm would hate to go back to the use of solid fuel. There was a very great deal to be said in favour of oil firing. They used waste-heat units for the drying rooms, for drying the enamelling plates before they were put through the first and second fires. That constituted an admirable economy, and the bigger the plant, of course, the greater was the saving to be obtained by the use of waste heat. He felt that the use of oil fuel was only just beginning to come into its own. When it was first used to replace other fuels in works, of course, mistakes were made, due to inexperience and ignorance, and Mr. Blackwell suggested that the oil companies should do rather more than they are doing in service to beginners. Mr. Unwin might reply that one had only to ask for such service in order to get it; that might be so, but he had not found the oil companies' service was anything like the service rendered, for example, by the Morris Motor Company to the user of the Morris car. Perhaps that day would come, for he felt certain that the oil companies would have to realise that as oil became more popular in industry the greater would be the demand upon their service departments.

MR. A. F. GIBBS said that he had seen the rotary furnaces in operation at Messrs. Armstrong's Scotswood works and had also seen a number of Sklénar furnaces in operation. As one concerned with the melting of non-ferrous metals, he asked whether the makers of these various furnaces were prepared to guarantee that the metal produced therein was equal to that produced in the pit-fired crucibles or tilting crucibles. He asked if the metal was oxidised to some extent in the oil-fired furnaces. He had gathered also that the sulphur content of the oil was fairly high.

MR. UNWIN said that the sulphur content was about 1½ per cent.

Life of Burners.

MR. GIBBS expressed the hope that that did not contaminate the metal to any appreciable extent. The makers of these different oil-fired furnaces had yet to satisfy the metallurgists of the railway company which he served that the furnaces could produce metal as good as that produced in the pit fire or tilting furnace. Again, Mr. Gibbs asked for information as to the life of an oil burner and the length of time during which it would be necessary to suspend the operation of the furnace in order to replace a faulty burner. Finally, he asked how many men were required to operate a rotary Armstrong furnace of one-ton capacity, and whether such a furnace was more economical in that respect than an oil-fired tilting furnace of 600 lbs. capacity.

MR. UNWIN, replying to Mr. Smeeton, said that the length of flame which could be obtained with oil could be controlled to within almost any limit; one could obtain a flame 12 in. or 18 ft. long. It depended upon the type of burner used, the amount of oil burned and the degree to which the oil was broken up. He had illustrated short flames particularly, not because long ones could not be produced, but because the production of short flames in oil-firing practice was more difficult than the production of long flames. Long flames could be produced quite easily.

MR. SMEETON said he was not concerned to obtain a long flame with high temperature at the tip only; he wanted a flame which would give off an equal amount of heat at every point along its whole length.

MR. UNWIN said that the size of the flame, of course, was not the same throughout its whole length. A long flame had a narrow trajectory; naturally it widened out after it left the burner, and afterwards it tailed in again to the tip. The radiation from an oil flame was high as compared with that from all sorts of other flames; it was a very luminous flame, due to the solid-carbon particles present, and naturally the direct radiation from the centre of the flame would be greater than the radiation from that portion of the flame in the immediate neighbourhood of the burner nose. He did not think he could say that one could produce a flame from which the radiation would be the same at every point along its length, but as a general rule the heat from the flame was such that it could be adapted to most purposes, and certainly in the furnaces which he had described the heat was quite even throughout, within small limits.

MR. SMEETON asked if that applied to direct-

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flame furnaces or externally-heated chambers of the muffle type?

Mr. Unwin replied that he was speaking of direct-flame heating. In the case of muffles, of course, which were indirectly heated, one could use a large number of burners, as was done in a gas furnace, and in some shorter furnaces the flame was distributed from one burner. One could not do better than be guided by Mr. Blackwell's expression of opinion with regard to enamelling muffles. He was a user of many years' experience, and managed to get perfectly even heating through a muffle 15 ft. long.

With regard to oxidising effect, Mr. Unwin pointed out that in an oil flame one had everything under control. In a coal fire one could not avoid a large excess of air, but one could control the amount of air which was admitted to an oil flame. If the oil were properly broken up it was possible to run with a very small excess of air over the theoretical quantity required for combustion, and one could also produce a reducing flame if necessary. So that if one wanted an oxidising effect one had only to turn on more air.

Discussing the use of an open-flame non-ferrous metal-melting furnaces, he said there was no necessity to burn off a lot of the tin and zinc. Of course, the experience of the operator had a considerable effect upon the results obtained, and no doubt a man with experience of working a furnace would have a lower melting loss than a man who came to it fresh and did not know exactly how to control the process. If it were desired to keep the metal entirely away from the products of combustion, one could always use a crucible furnace, although that did not constitute an absolute bar.

As to the number of heats which the lining of an oil-fired furnace for melting cast iron would give, Mr. Unwin said the figure in the calculation he had referred to was 80. The figure given by Mr. Smeeton in respect of the pulverised-coal-fired furnace was from 70 to 100.

Mr. Unwin said he could not give a figure representing the consumption of fuel oil per ton of enamel castings treated, because the figure varied so much with the class of work being carried out.

Phosphorus Pick-up.

Dealing with the chairman's question as to the pick-up of phosphorus when changing over from iron melting to steel melting, he said that the figures he had quoted were the results of a test, and he admitted that possibly in general practice it would be very inadvisable to step over immediately from iron to steel melting. But if a furnace were being run entirely on steel, he did not think the trouble referred to would arise.

Oil-Fired Cupolas.

Replying to Mr. Delport, he said he did not look upon the coke-fired cupola, in this country at any rate, as a sort of apparatus which could be oil fired satisfactorily, either from the technical or economic point of view. Generally speaking, the costs of melting by means of oil applied to a cupola would be considerably more than the costs of melting in that cupola with coke, and he felt that if oil were to be used for melting iron, it was better to employ a furnace which was specially designed to take advantage of liquid fuel than to use liquid fuel in a type of furnace which had been developed specially for using coke. Experiments had been carried out in this country, but they had never led to any wide use of oil-fired cupolas, and he did not expect that they would.

Sulphur Contamination.

After thanking Mr. Blackwell for relating his experience as a user of oil fuel, Mr. Unwin went on to deal with the question of sulphur, and said that the grade of fuel which had been employed at the particular works in question was a standard grade; if there had been no trouble there due to this cause—and he did not think there had been—he did not see why there should be any such trouble on a similar type of plant anywhere else.

He was afraid that Mr. Blackwell must have been unfortunate in his experience of the service given by oil companies, because it was his (Mr. Unwin's) experience that they always did a great deal for users of oil fuel.

Replying to Mr. Gibbs' remarks concerning the quality of metal produced by the Armstrong-Whitworth furnace, he said that if one had any doubt about what the reverberatory furnace could do, one could always employ a crucible or tilting furnace. The fuel consumption on the most modern type of tilting furnace was quite reasonable, and, of course, tilting furnaces were used largely in those cases where, for some special reason, the metal must be kept out of contact as far as possible with the products of combustion. The sulphur content of the fuel oil was 1.5 per cent. It must be remembered, of course, that there was sulphur in coke and in coal, and when it was borne in mind that normally one used about 1 ton of oil to do the work of 2 or 3 tons of solid fuel, and when one compared the sulphur content of the 2 or 3 tons of solid fuel with that of the 1 ton of oil fuel, there was no more sulphur introduced by the use of oil than by many of the solid fuels.

Oil Burners.

Discussing the oil burners, he said that the chief grouse of the various sellers of this type of equipment was that it did not wear out fast enough, and that they did not obtain repeat orders for that reason. Generally speaking, the cost of upkeep of burners was so small as to be entirely negligible. Occasionally there were maintenance costs incurred on blowers or fans, or motors driving them, but he knew of burners which had been in use for 25 years and on which not ½d. had been spent. He did not advise that policy, because he considered that a great many people would do well to replace out-of-date equipment by up-to-date equipment more often than in fact they did. The considerable strides that had been made in the development of oil burners recently were not generally realised, and that was one reason why he had indicated the difference between the effects produced in atomising an oil in a comparatively modern burner and in a really up-to-date burner. One could "unship" a burner and replace it by another within a minute, if one had a suitable type of fitting specially designed for the purpose. One might have a couple of nuts on flexible pipes which could be unscrewed, plus a screw for taking out the burner. Then one slipped in the new burner and merely tightened up the screw and the two nuts. He did not think that there was very much difference between the labour involved on a tilting furnace as compared with a reverberatory furnace; comparing the two furnaces, of equal capacity, the amount of labour involved in pouring the metal out would be more or less the same in each case.

Vote of Thanks.

Mr. Bagshawe, proposing a vote of thanks to Mr. Unwin, said that the developments in the use of oil-fired furnaces would probably be very important to foundrymen in the future, and he suggested that it would be valuable to have another Paper on this subject presented two years hence. He agreed that the future of oil firing in this country depended more upon the service given to the beginners by the oil companies than upon anything else. He complimented Mr. Unwin on the manner in which he had handled a difficult subject. Mr. Smeeton seconded, and the vote of thanks was carried with acclamation.

Mr. Unwin, responding, said it was a great pleasure to him to be able to help to solve some of the problems arising in the foundry, and intimated that he would be glad to give additional information at any time in the future, if it were required.

German Steel Industry.

POST-WAR DIFFICULTIES.

The subject of the struggle for life of the German iron and steel industry was discussed recently by Herr. J. W. Reichert, general director of the Association of German Iron and Steel Masters, at a meeting held in Essen. At the outset the general director stated that besides the outbreak of the war and its unfortunate issue, the invasion of the Ruhr district was the third heavy blow which affected the steel industry in a single decade. Unfortunately the Government had hitherto not employed the necessary Customs and commercial-political methods to be able to assist the distressed steel industry in its struggle for existence. The lack of State assistance had led to a system of industrial measures of self-help, including the formation of combines and cartels, international understandings, and last but not least the Avi agreement concluded with the German finishing and consuming industries. If these industrial measures of self-help had not checked at least partly the dumping of goods from abroad, the German ironworks would long ago have been brought to a standstill by the flooding of Germany with foreign iron and steel. The agreement with the Avi customers was the best proof that the steel-producing industry had never thought of abusing its economic position. In 1925, for instance, the Steel Ingot Syndicate decided under the Avi agreement to supply inland consumers with material at the world-market prices while at the same time waiving the difference due to the import duty. The results had been highly remarkable from a national-economic point of view. While in 1913 the value of the export excess obtained by both producers and finishing works over the imports amounted to 2,000,000,000 mks., in the past few years the excess for both the producing and finishing industries increased to 2.7 and 3.1 milliards of marks. Without the maintenance of an efficient steel-producing industry at home, the finishing works would have been compelled to get large quantities of foreign material, and thus the excess of exports would not have reached the level mentioned.

The mutilation of the concerns of Thyssen, Klöckner, Deutsch-Luxemburg, Röchling, Rombach and Stumm and the cutting-off of prominent ironworks, due to the Versailles treaty, demanded a new combination of works full of vigour. The zeal of concentration in the post-war period grew further in consequence of the continued scarcity of raw materials. Some concerns, like Rombach and Stumm, had already fallen victims to the crisis in connection with the Dawes tribute in 1925-26, while the Siemens-Rhein-Elbe-Schuckert Union proved in the long run to be unsuitable and was therefore dissolved.

The increases in taxes and social welfare contributions, in connection with the reparation payments, represented the most dangerous preliminary burden on German production in relation to foreign competition. The six leading concerns in the West German industry during the five years 1925-26 to 1930-31 were compelled to pay in taxes and social welfare contributions the enormous sum of 1,000 million marks. This diversion of capital represented a public burden which, measured by the profits earned in these years, was about equal to as much as six times the corresponding public burden borne by the American industry. In any case the German public burdens were so heavy that they alone had sufficed to pass on to the State and other public authorities all the benefits derived from the measures of rationalisation instead of to shareholders. If a balance-sheet of the State's gains and losses were drawn up it would be found that there was a great deficit in the case of the steel industry, as the assets were far exceeded by the items on the debit side of the account. The greatest self-help of an industry in the long run, concluded Dr. Reichert, was of no advantage if private economic measures were hampered or entirely nullified by the State, as had been the experience in the post-war period.

Mr. Frank Rees, managing director of the Llanelly Steel Company, Limited, on his re-election as President of the Swansea Metal Exchange, recently, emphasised the benefit of protection for the steel trades. Reviewing the position of the iron and steel industries in the light of the 33⅓ per cent. import duty on foreign products, he said that the prospects in South Wales were brighter at the moment than they had been for a considerable time.

Plaster Patterns in General Foundry Practice.*

By Robert Ballantine.

Pattern Costs.

The question of pattern costs is one which is always prominent, and whenever the executives of the engineering business hear these costs mentioned they are at once characterised as the bugbear of the engineering industry. It is very strange, indeed, in view of this attitude, that alternative methods and alternative materials are not more fully considered, and adopted, in pattern construction as a means of their cost reduction.

Material.

Plaster of paris, or stucco, as it is known in Scotland, is fully exploited in the light-casting industry as a patternmaking medium. Why its many splendid qualities have not been exploited in the general engineering foundry is a matter

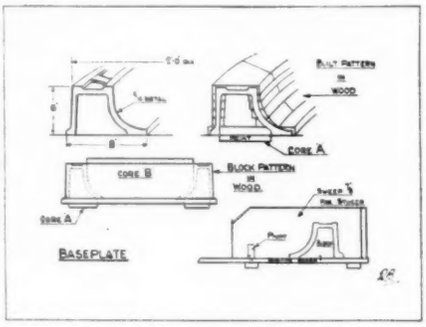


FIG. 1.—SHOWS A BASEPLATE SECTION IN WHICH THE METAL IS $\frac{9}{16}$ IN. THICK, WHILST ONLY FOUR CASTINGS WERE REQUIRED.

of amazement to many. The material itself is quite cheap, and is supplied in three grades—coarse, fine and superfine; the first two qualities being mostly suited for general foundry practice and the superfine quality for architectural work of delicate design. Stucco is obtained from gypsum, which is a comparatively soft mineral. Chemically, gypsum is hydrated sulphate of lime, including small impurities such as calcium carbonate. It is subject to a baking process, and

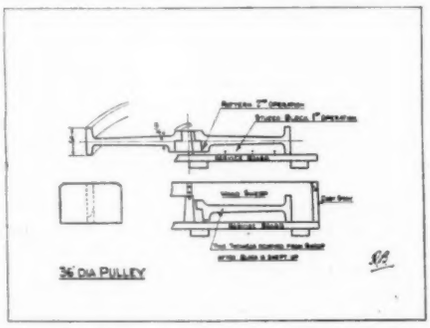


FIG. 2.—SHOWS A 36-IN. DIA. PULLEY, THE FACE OF WHICH IS 3 IN. DEEP AND THE CENTRE WEB TAPERING FROM $1\frac{3}{8}$ IN. TO $\frac{7}{16}$ IN.

the residue, ground, to reach the foundry as plaster of paris.

Boxes for storing the stucco should be lined with metal, and every precaution taken to prevent dampness reaching the plaster. Otherwise, if lengthy periods elapse between usage, a certain amount of the virtue is lost and an unsatisfactory pattern is the result. Mixed in water to the consistency required, and with a little Irish lime added where greater strength is necessary, which somewhat prolongs the setting, the material is ready for use after careful mixing.

When large patterns are made, it is necessary to prolong the setting of the material for sweeping operations, and various additions are made. Briefly, these are as follows:—For toughening, a mixture of 4 to 5 per cent. of cornflour is added. With the same percentage of water from marshmallow roots, after boiling, the setting can be held back for an hour. With an increase in these additions, the hardening is intensified and the setting retarded.

Methods of Working.

For the working of stucco, strickles or sweeps are usually made in wood, and these are quite satisfactory for ordinary jobbing foundry practice. Should they be required occasionally, they are faced with zinc templates, which are made to the section required and screwed on the face. One for running up the block and the other for the thickness or pattern. The operations are similar for straight or radial work. Various sizes of service boards are necessary. For straight work, one edge of the service board must be perfectly straight, so that the sweep is guided correctly in the work. In the case of circular patterns, a pin takes the place of the edge guide.

It is essential that the sweep be well varnished and oiled, to facilitate the easy removal of the stucco from it whilst in operation. A tendency to stickiness develops in sweeping off the surplus stucco, and if the sweep is clogged with semi-solid plaster it hinders operations very considerably.

Operations.

An occasional sprig is put into the service board to about half its length, and these are placed so as to clear the sweep and hold the block whilst being run up. After the block is swept up it is varnished, two coats generally being given. The template is then altered by removing the wood which represents the thickness of the pattern desired, or, in other words, the actual pattern. Before proceeding to run up the pattern, a coat of boiled linseed oil is rubbed over the block to ensure the easy removal of the pattern from it. *Boiled* linseed oil is preferable, being less liable to be absorbed by the stucco than are other oils.

The "fine" quality of stucco should be used for the pattern, and great care in mixing should be taken. Clean water is important, and this is first put into the mixing bucket. The dry stucco is taken by hand and sprinkled over the water, immediately sinking to the bottom. Additional stucco is put in, until it appears as a small pile above the water level. The hand is then immersed, and a squeezing effect takes place for proper mixing, by closing the fingers into the palm of the hand gently. This should be done speedily, as over-mixing weakens the plaster. Moreover, the hand should cover every part of the mixture for uniform consistency. No further water or stucco should be added if the very best results are to be obtained, and, further, too many mixings on the one operation, especially on thin sections, is disastrous, just as too frequent use of the sweep weakens the structure. Swelling takes place, but if proper mixing, along with a study of the particular jobs under construction is undertaken, these do not present any great problems.

Camber.

Should it be necessary to camber any job, as is very often necessary, the bed can be made by fixing two camber strips on a service board and filling in with stucco before proceeding with the other operations. Edge guides for straight work, centre pins for round work and bottom-plate guides for irregular section patterns, are common to most stucco work, and to a very marked degree mechanical accuracy is accomplished. Hand tools can also be used in shaping these patterns, and in planing, chiselling or gouging them one has the decided advantage of not having cross grain, knots or shakes to contend with. It is a splendid material and can be swept or strickled to very fine limits, which one could never hope to attain in wood.

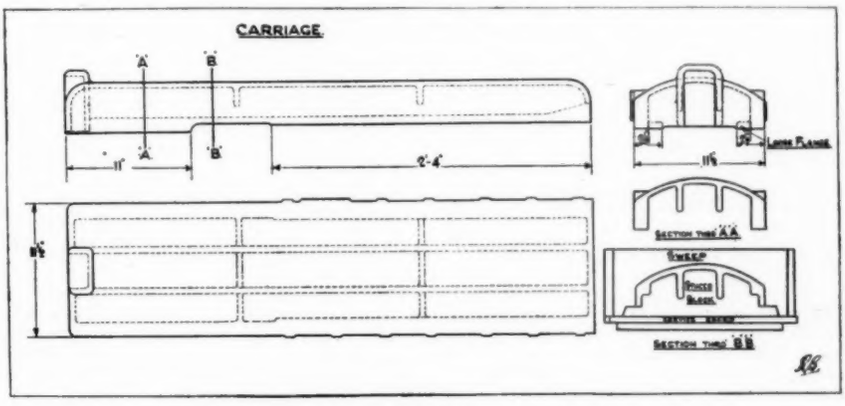


FIG. 3.—SHOWS A CARRIAGE AS AN EXAMPLE OF STRAIGHT SWEEPING.

Patternmaker.

A highly-skilled stucco patternmaker is a rarity in an engineering patternshop, and those available are usually entrants from the light-casting industry. It would be a revelation for the engineers' patternmaker to visit some of these light-castings patternshops and see the craft and ingenuity displayed in the making of complicated patterns. The patternmaker develops a sense of feel when working stucco and bearing in mind the speedy setting of the material, means quick movements on his part.

Speaking as one trained in the art of plaster patterns, and as one who believes the adoption of this medium would reduce patternmaking costs very considerably, there are many factors to be considered, both for and against its general use. Observations have led to the finding that if a patternmaker is any length of time in the wood section he has no desire to return to the stucco because it is a messy job, and unless separate shops are provided for the working of it its many splendid qualities will not be advanced.

But perhaps three of the greatest drawbacks to its general use in engineering patternshop practice are (1) the lack of knowledge as to its qualities shown by the management and em-

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. Dudley Campbell presiding.

ployees, (2) the transport problem, due to the fragile nature of the material, and (3) the development and equipment of the modern patternshop with motor-driven high-speed woodworking machinery. In the first instance, the management is not sufficiently aware of its possibilities, and the workmen are either artisans in stucco only or in wood. This state of affairs has gone on for years, and no doubt, if one asked the engineering patternmaker if he could run up a given pattern in stucco, his answer would be "No." On the other hand, the stucco-trained patternmaker is at a loss if presented with a blueprint for the making of an intricate engineering pattern. The problem of the management here is, they are left with the alternatives of securing adaptable men or training their apprentices to both branches.

The second objection is the transport problem. Where a foundry is remote from the patternshop, one is sceptical in considering the introduction of stucco patterns, due to the fragile nature of the material, but, with the light motor lorries and the heavier stucco thicknesses used in engineering practice, there is no reason why breakages should not be kept at a minimum.

The final objection is the incidence of machine tools associated with the development and introduction of high-speed and motor-driven woodworking machinery to the patternshop, which, combined, have created a formidable opponent and to a very great extent have stopped the advancement of stucco patterns. Only a few years ago patternshop equipment consisted of a band saw, a circular saw and an obsolete turning lathe, whilst the more fortunate shops had a planing machine. The result was much wasted time in an ordinary-sized shop. Compare these with the modern patternshop, where all machines are motor-driven; there are no belts, and the band saws now run at 950 r.p.m. in place of 400. Moreover, they have tilting table, push-button control, and brakes. Then there is the dimension saw with two saws, one for cross-cutting and the other for shallow rips. The saws are adjustable for depth of cut, and angling fence arrangements are provided.

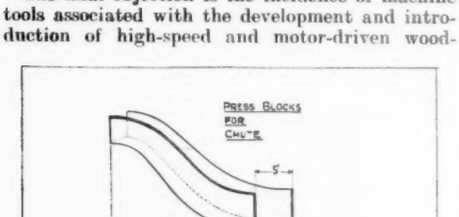


Fig. 4.—Shows a Press Block for Shute.

The patternmaking machine or wood miller is an ideal tool for a large shop, and with an intelligent operator can turn large quantities of intricate work. The modern combination planer, or the "over and under" as it is sometimes called, with balanced cutter-block and running in ball races, can turn out timber ready for use, and free from dip and furrows which remind one of rocky roads. A routing machine for recessing, a double-disc sander, an oscillating-belt sander, with variable bobbin for inside radii, jig saws, with boring attachments, turning lathes, with motor-driven headstock, and the many other tools, such as minature planers, sanders and saws, which are appearing, all indicate the progress and development, which must necessarily retard alternative methods of production. Consequently the advancement of stucco as a medium has suffered.

Research.

In the foundry, research on metals, sands and melting equipment, etc., still proceeds, and in this age of progress the results justify a continuance of research on these lines. In the patternshop, the orthodox timber holds first place, and rightly so, but with stucco an insignificant second. Why should it be thus? Surely it is as essential that research should be carried on with materials which will eliminate "shrinkage," "swelling," "cross gain," "end wood," "twist," "shakes," "knots" and "dampness," the many objectionable features which timber as a patternmaking medium holds.

One can easily say "Why spend time and money on patterns?" which, to the unthinking, never appear in the finished articles, but both from the foundry and engine-shop point of view, a first-class pattern means everything. With a bad pattern, a bad draw is only to be expected, and all advantages gained by careful ramming are lost in the making up, and wasters can be traced in most cases to this source. From the engine-shop point of view, it is quite right in objecting to two or three operations in machining if one is really sufficient. Their cry is rightly that far too much metal is left on. If provision has to be made for dirt, then it should be made before the job leaves the patternshop, for quite 70 per cent. of green-sand defectives can be traced to patching of moulds, due to inferior patterns. Any means adopted to make patterns as near the ideal as possible is money well spent, and, after all, why ram a job, if one, when watching the pattern being withdrawn, sees the mould left like a sand pit. Withdrawing stucco patterns from the sand does not cause any trouble. They come away very easily, due to their smooth surface, and the moulds need a minimum of touching up. Moulders who are unacquainted with working from stucco patterns are, as a rule, frightened to ram them in the ordinary way. The very fact that the ramming is done against the block on which the pattern lies, lessens considerably the tendency to excessive breakages, which naturally one would expect if this procedure were not carried out. Should it so happen that the pattern is unweildly, then it can be cut in sections for easy removal. Stucco patterns can be stored for years if need be, provided the stores are kept at a normal temperature. Moreover, if alterations to existing patterns be required, the surface can be raggled and remodelled with fresh stucco. The extremes are the rule where stucco is mostly used, that is, in the making of patterns for one or two off, and in the making of master patterns for standard metal ones. This much can be said, endless opportunities arise where the use of both wood and stucco can be successfully carried out in one pattern. A splendid one-off pattern can be swept up in very little time, and in many cases encountered stucco patterns have been swept up, taken to the foundry and cast, while a similar job in wood was being built up methodically.

With the ever-increasing demands put on foundries in supplying high-quality castings to meet the competition of weldings, it is equally the same with the designer. He visualises a structure or machine as a unit, and sharp corners give way to nice rounds. These eventually give way to larger rounds, and cause endless trouble in pattern construction. In fact, it becomes quite a problem at times how to overcome the frail nature of the pattern for foundry usage, and in most cases it means either excessive coring or innumerable stiffening bars, which have to be filled up afterwards.

Foundrymen are very prone to blame design for many of their failures, and with very good reasons at times for doing so, but in a great many cases the designer's aim is for beauty of outline consistent with a serviceable product. After all, castings which have sharp corners may serve exactly the same purpose as castings with nice radii, but the fact remains, one develops a taste for symmetrical lines in any casting or machine, which is often an important factor to any intending purchaser. Running up patterns in stucco with large rounds is a comparatively simple operation.

A continual source of annoyance to the foundry, and to the patternshop also, is the "built" pattern, with segments built up in brick-band formation. The greatest care may be taken in constructing patterns of this type, but it is found that after finishing, either by turning, disc sanding or planing, that the soft or "side" wood shrinks below the end wood of the next layer. In most cases this happens when the pattern is ready for the foundry, or is actually in the foundry. Should the moulder receive it in this state, one can visualise the expressions used as to the patternmaker's stupidity!

On the other hand, the patternmaker expresses himself very forcibly about the dampness of the timber, and if the buyer would buy the best yellow pine these difficulties would solve themselves. Actually, both views are wrong. A fresh cut in timber leaves a new surface to the air, and the grain of the wood not running radially with the segments leaves each segment with a "soft side" part and two end parts which are hard.

Stucco patterns have not this objectionable feature and do not tear a mould. They cannot stand much rapping, but there is no real need for rapping as the pattern strips very sweetly. The examples of stucco patterns used in producing electric motor castings were shown, which are typical of what can be done in general and marine practice. An aluminium model (shown) was complete, and all castings up to certain sizes were made from original stucco patterns, including the internal-fan arrangement.

The use of stucco is not only restricted to patterns and core boxes. Mr. Pillon in the French exchange paper, read at the Newcastle Convention, refers to the use of stucco in making irregular partings on turnover boards. Then odd-sides for general use either for floor or machine moulding can be made with very little trouble, controlling, of course, the mixture of stucco sufficiently hard for the particular job. In the making of permanent moulds, it can be fully exploited by the making of plaster casts

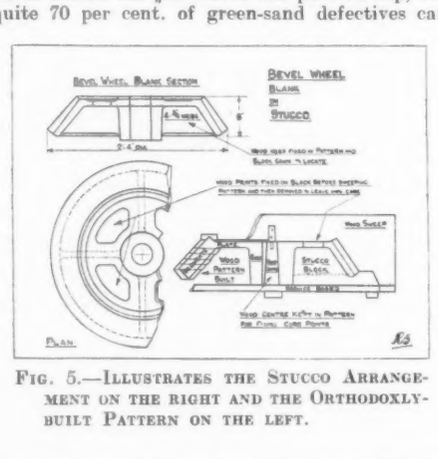


Fig. 5.—Illustrates the Stucco Arrangement on the right and the Orthodoxly-built Pattern on the left.

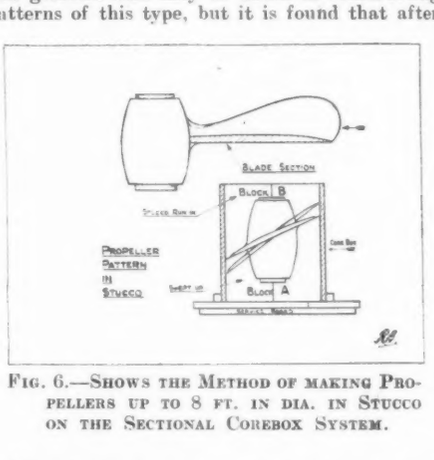


Fig. 6.—Shows the Method of making Propellers up to 8 ft. in dia. in Stucco on the Sectional Corebox System.

from existing patterns. These casts, in turn, being used for the production of the permanent mould. It is very much easier to make a pattern for the article to be produced and then make the plaster casts, than to cut the pattern in relief from blocks.

BASE PLATE SECTIONS.

Types of Patterns Suited to Stucco.

The illustrations accompanying this Paper give one a fair idea of the types of patterns which can be profitably made in stucco. Fig. 1, for instance, shows a baseplate section in which the metal is $\frac{9}{16}$ in. thick, whilst only four castings were required. To construct this pattern in wood leaves one with three feasible ways of doing so. The likeliest method would be to build from a bottom layer in sections, and in brick-band formation to the desired height and cover with a top layer. After turning in the lathe on a cross-section faceplate, a bottom print would be added for core "A." A segmental core box completing the job. Another way would be to turn out the inside in place of coring—*a fine example of very bad practice*, due to timber variances.

Still for a 4-off job some may prefer a block-pattern with top and bottom prints as shown, and a core box for the inside, and the section core box as mentioned in the built pattern. One could not be too happy with any of these plannings, and if money is saved on the patterns, then the foundry costs increase. The most satisfactory and by far the cheapest plan would be to draw a section on a piece of wood, and form a sweep from it. Fix a pin at the radius and strike up a block in stucco on a service board, which gives the inside of the pattern. Then, alter the sweep by cutting away the wood which represents the thickness of metal, and proceed to run up the pattern after the block has been varnished and oiled, the cross-facing strips on top being put on in wood or stucco afterwards. The pattern can be cut in four sections, similarly to the examples shown, for ease of handling.

This method has much to commend it—a regular thickness of metal is assured. The compared prices in patternmaking would show an approximate saving of 50 per cent. on material and labour, and the casting price would hold its own by being made entirely in greensand. There would also be more speedy delivery of the job—a very big factor nowadays.

A 3-ft. Pulley.

Fig. 2 is another example of radial sweeping. In this case a 36-in. dia. pulley was required. The face is 3 in. deep, and the centre web tapers from $\frac{13}{16}$ in. at the boss to $\frac{7}{16}$ in. at the rim. The bore in the boss is recessed to receive a ball-race and there is only $\frac{1}{4}$ in. machining allowed on rim diameter. The pulley is dynamically balanced in the machine shop, so that a dumpy or twisted casting is useless. Making a pattern for this pulley in wood involves building on a centre plate and turning one side, and then a reversing operation in the lathe, due to tapering centre web.

To the author it seems a laborious and unsatisfactory job. No matter how careful or efficient the patternmaker is, the centre web varies the breadth way of the timber. In checking the pattern before despatch, it would probably be found that it is at least $\frac{1}{8}$ in. under size, and a last-minute rush to add a piece of cardboard or floorcloth to make it up. The same pattern, after being withdrawn from the sand, would swell and vary out of all proportion to machining allowances.

Now, stucco patterns cut out this, for, should it be a one-off job, it can be run up in stucco, or even for three or four castings; and if it be a standard job it can be run up as a stucco pattern and a metal pattern made from it.

A Carriage Pattern.

Fig. 3 shows a carriage about 4 ft. long and to the sections indicated. This is an example of straight sweeping. The stucco block is swept up as shown on section BB, the varying depths being cut in the block before striking up the pattern. The lengthway webs are part of the stucco pattern, and are well tapered. The cross webs are put on afterwards in wood. Hand work is necessary in this job, owing to the large round at either end, but the block is rounded before the thickness is run. This example was cast in aluminium, in green sand. The end pocket core only dry sand.

A Shute Casting.

Fig. 4 shows a shute, and a press block or die casting was required for a finishing operation in the manufacture of these shutes, which are of $\frac{1}{16}$-in. thick copper. Wood was out of the question for accurate male and female patterns. The shute was a work of twists and turns, but the contour was perfect. A top and bottom box were first made, and the latter set on a board. The copper shute was tilted and temporarily fixed in the position shown. The stucco was poured in and scraped to the top, 3-ply wood pieces being placed at either end to stop the stucco from entering the inside. After touching up for drawing at the right-hand end, it was varnished and oiled. The top box was next placed on and the stucco again run in. Any little variation was easily carried out. It is pleasing to state that the castings were highly satisfactory and the patternmaking costs favourably commented on in comparison with others made in wood.

Bevel Wheel Blank.

Very few foundries exist which do not make at some time or other a bevel wheel blank, such as is shown in Fig. 5. One can easily remember the amount of "scrounging" and patching to get something which could be adapted, and in most cases the time and patience wasted in these makeshift arrangements are far more costly than making a new wooden pattern. The same applies to gear-wheel blanks. It is advisable to *sweep up the pattern in stucco*. The patternmaker should draw a section on a piece of timber in any case, and then utilise it as the sweep as shown in Fig. 5, which illustrates the stucco arrangement on the right and the orthodoxly-built pattern on the left. The saving is obvious—monotonous segment cutting and building; finding a suitable faceplate, wondering if one is free from nails during turning; and the usual snag of reversing in the lathe; coring and putting on the finishing touches. When complete it represents a nice patternmaking job, but a costly one. Compare it with the stucco pattern. Here the sequence of operations is—sweep block and form a pattern which can be swept up as quickly as the wood segments are built; the wood pieces are disc-sanded and fixed to the block before the "thickness" is run up in order to leave the four holes ready for varnishing in the finished pattern.

Propeller Making.

The suggestion is put forward that propellers up to 8 ft. in dia. should be made in stucco on the sectional core-box system, such as is shown in Fig. 6. First secure a service board, and if a four-bladed propeller be on order, draw a quarter-circle to the diameter necessary and radial lines at 90 deg. converging at the centre. Next fix the spindle and gable. After the strickle is in order, fill up the bed with foundry coke or rubble from old stucco patterns, allowing 1 in. clear for new stucco. The sweep can be made in striking out the barrel as well as strickling the bed, but, due to the fact that the barrel is rounded, the sweep must be made to strike out the smallest diameter. Thereafter the barrel is gouged to shape and the rounding of bed for the filleting of blade on the striking face is done by gouge and spokeshave. The bed would now be varnish painted, after scribing, radial lines for the blade sections put on to it.

The sweep would next be altered by removing the wood which represents the blade section at the thickest parts, and also the top half of the barrel at the largest diameter. The bed would now be tilted to keep the stucco from running off too much whilst the blade and barrel combined are being swept. The blade can be easily shaped by hand, and if small stucco cubes are placed on the bed with painted tops to the required thicknesses, the back of blade contour is easily formed. The top half of the barrel is then rounded.

The gable and spindle are now removed and the 90-deg. angle sawn through bed and barrel. After the necessary varnishing and oiling, the quarter-core box is slipped over the blade and bed on to the service board, and a top bed or block poured in. At the finish it means there is a bed which becomes block A, in the section, and another block B, with the barrel and blade combined between these blocks. These blocks can be removed as desired and the respective cores made, the blade finding its location in either block.

Compared with the present system and up to the sizes given, abnormal savings can be accomplished by this method. When the cores are placed together and cast, there should be a nicely-balanced propeller casting, with no appreciable variances in the blade. The load operation would be entirely eliminated and the patternmaker setting the work in the foundry would be unnecessary.

Most founders can visualise the competition from welded products for this class of work in the near future. By adopting alternative patternmaking methods and materials, it is hoped to combat this menace.

The author has intentionally refrained from taking up the light-castings methods in the use of stucco, just as he has omitted the plaster odd-sides and methods for machine moulding, believing these branches of the craft are worthy of special papers in themselves.

Finally, despite the cheering news which one hears as to castings holding their own as against fabricated products, founders must explore and exploit every avenue to retain their hold. This can be accomplished in many instances by making patterns to give accurate metal thicknesses and by giving the designer what he wants.

In conclusion, a definite field awaits the plough in progressive patternmaking by the introduction of plaster patterns in general foundry practice.

The author desires to express his thanks to the directors of Messrs. Thomas White & Sons, Limited, Paisley (incorporating John McDowall & Sons, Limited, sawmill engineers, Johnstone), for the privilege granted him in preparing this Paper, and also his thanks to Mr. Sharp for giving him examples of light-casting stucco work.

U.S. Order for Regulating Manganese Ore Imports.—The order is severely criticised by a correspondent of the "New York Times." According to the writer, as manganese ore is a commodity similar to iron ore, imported in cargo lots of anywhere from 6,000 to 10,000 tons, and in its physical nature is similar to iron ore, the new order will prevent the importation of this commodity until the matter is definitely settled. As the cost of mining manganese ore is about the same as the mining of iron ore, and inasmuch as manganese ore is already protected to the extent of $11 a ton for 50 per cent. ore, it would seem that this would be sufficient to encourage American producers of manganese ore and be full protection to them in regard to their labour costs. However, the owners of domestic ore say that this duty is not sufficient and that an embargo should be placed on its importation. But inasmuch as it has been shown that there is not sufficient ore in the United States and there are very few large deposits of manganese ore of sufficient grade to make ferro-manganese, the embargo would be a most serious matter if it lasted any length of time, and most costly to the steelworks of the United States.

D

The Witton High-Frequency Electric Melting Furnace.

By Verdon O. Cutts.

Collaboration between representatives of different branches of science invariably proves of benefit to all. In no instance is this fact more evident than in the field of electro-metallurgy. The close co-operation of the electrical engineer with the metallurgist has rendered possible industrial achievements which were previously unattainable. The development and application of the high-frequency induction electric furnace is one of the most recent examples of this and probably the most important, and has enabled steel and other alloys to be produced economically and under improved workshop conditions, having a purity and precision of composition which cannot be obtained with any other type of furnace.

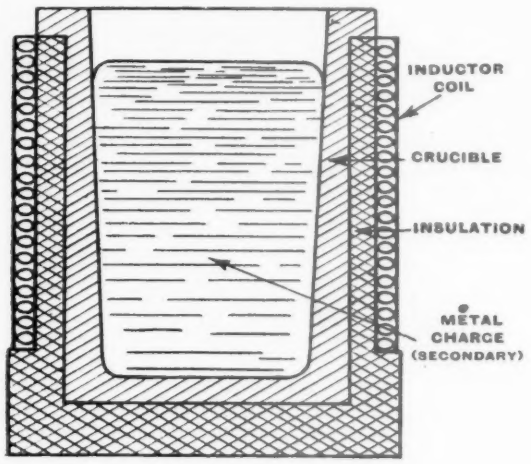


Fig. 1.—Coreless Type of High-Frequency Furnace.

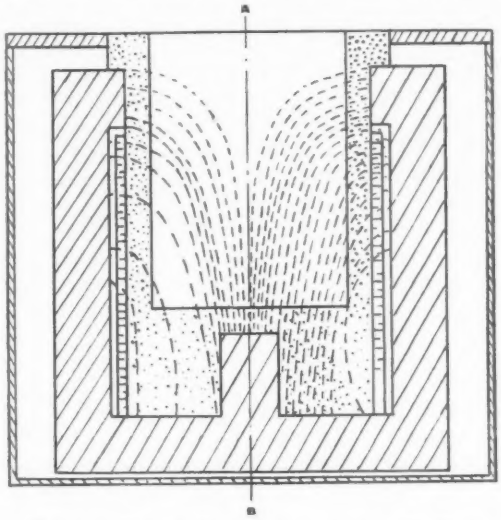


Fig. 4.—Witton Furnace: left of A B, Flux Distribution without Charge; right of A B, Flux Distribution with Charge.

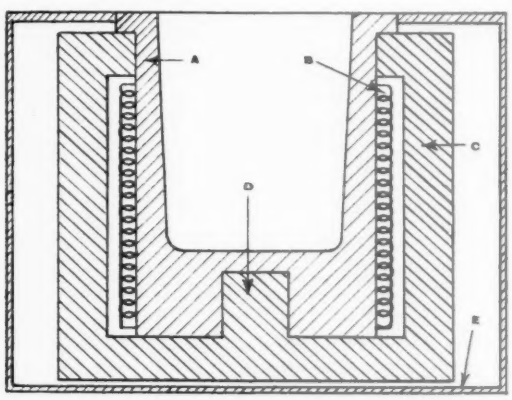


Fig. 2.—Cross Section of the Witton High-Frequency Furnace.

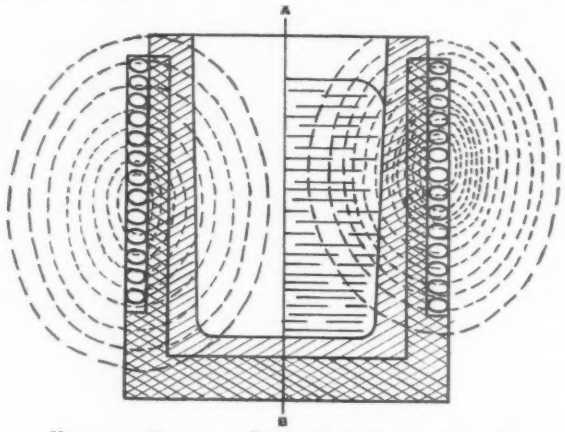


Fig. 3.—Coreless Type Furnace: left of centre line A B, Flux Distribution without Charge; right of A B, Flux with Charge.

Basic Principles.

It is well known that if a piece of steel, or other metal, be placed within a coil of wire, through which an alternating current is passing, the alternating magnetic field produced by the current produces an electric current in the piece of steel, which becomes heated. The heat produced varies as the square of the current. The strength of the induced current depends, other factors being equal, on the strength of the magnetic field which passes through the steel and, to a lesser extent, on the periodicity of its alternations. The magnetic field depends, again assuming other factors are equal, on the ampère turns per unit length of the inductor coil. Thus, for a given size of inductor and a given metal charge, the temperature that the charge will gain can be determined with precision by measuring the high-frequency current through the inductor.

This describes in the simplest possible manner the basic principles of high-frequency induction heating. Other considerations, such as the depth of penetration of an alternating magnetic flux into a metallic charge, are the intimate concern of the designer rather than the user, and do not affect the broad principles outlined in this general statement.

Development.

Older and well-known types of high-frequency furnaces are of the coreless type, and represent a natural transition from the well-known, low- and normal-frequency, core-type, induction furnaces. When the iron core was dispensed with for practical and metallurgical reasons, it was found necessary, in order to obtain a secondary current of sufficient value to melt a body of metal, to increase the frequency of the current in the primary coil. Such furnaces (see Fig. 1) consist essentially of an inductor coil, which is a helix of water-cooled copper tubing, with a crucible containing the metal charge which forms the secondary. They have proved of great value to the steel and some non-ferrous industries because they have presented to the metallurgist a melting unit capable of attaining any temperature within the practicable range of available refractories without any possibility of contamination of the charge by carbon, sulphur or other deleterious elements. Invaluable though their use has undoubtedly been, a critical examination suggested the possibility of substantial improvements being made. It was realised that with the removal of the iron core, the conductivity for magnetic flux had been reduced to the magnetic conductivity of air with the corresponding reduction of flux. Also, the fact that the magnetic field was uncontrolled as regards its distribution, pointed to the presence of stray magnetic fields which not only had the effect of limiting the efficiency of the furnace, but made it imperative that no magnetic material should be used in the construction of the furnace. This, obviously, accounted for the use of asbestos

cement and even wood for the furnace casing and for the fact that the inductor coil could not be more adequately supported externally to withstand the pressure of the charge from within. Subsequently, a structural steel body or casing was adopted for the coreless-type furnace, a magnetic shield of sheet copper being introduced to prevent overheating of the furnace casing by the stray fields. This, however, was only a palliative. The problem still remained how to make the transition from the old and well-known, low- or normal-frequency, core-type, induction furnace to the high-frequency furnace, without incurring these disabilities.

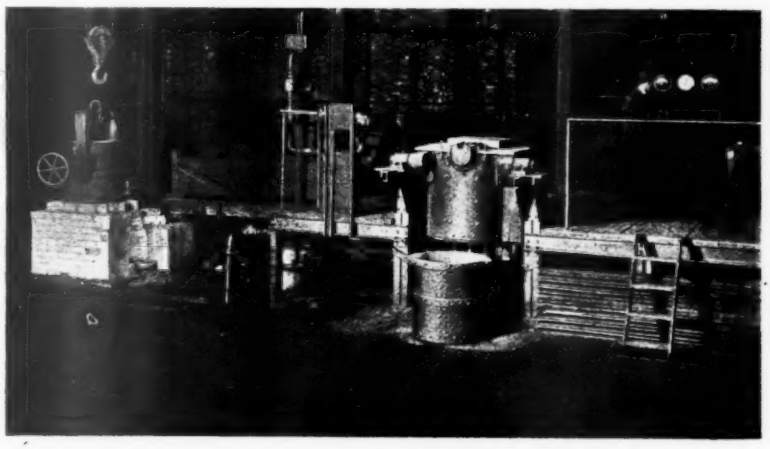
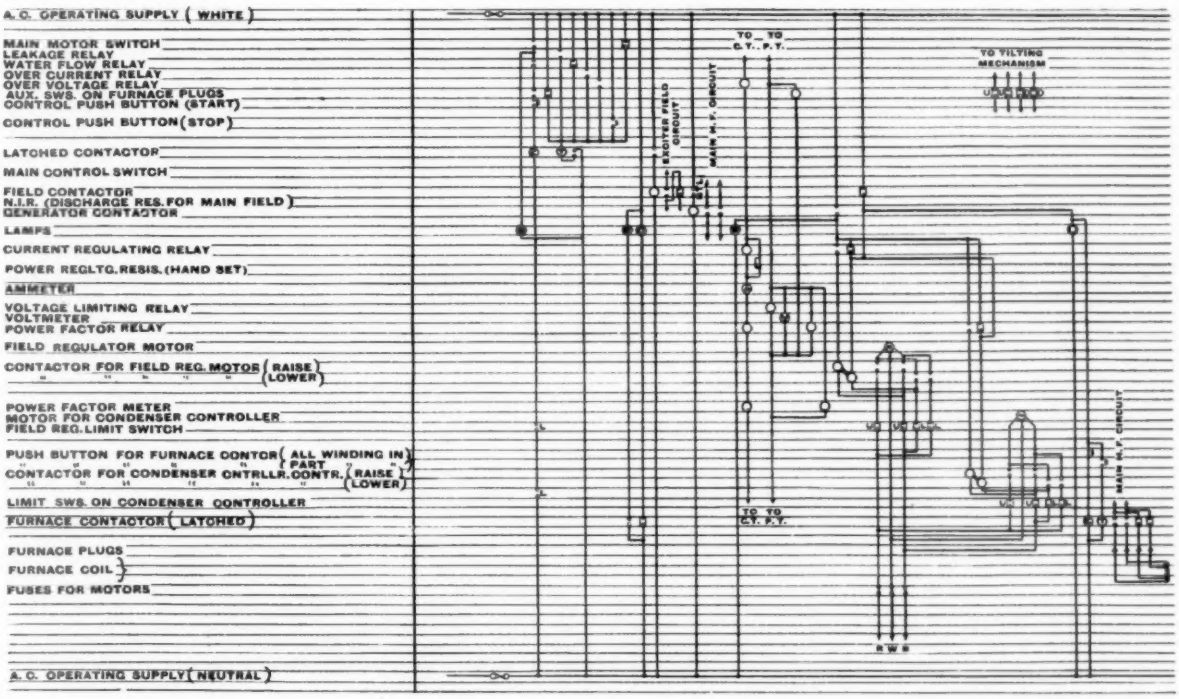


FIG. 5.—WITTON HIGH-FREQUENCY FURNACE INSTALLED IN THE NORTH OF ENGLAND.



Contactor or relay operating coil.

Closing and tripping coils respectively on latched type contactor or breaker.

Contact on circuit breaker, contactor or relay, which closes when the operating or closing coil is energised.

Contact on circuit breaker, contactor or relay, which closes when the operating coil is de-energised.

Auxiliary contact, closing with main contacts but fitted with time delay when opening.

Push-button switch; push to close circuit.

Red, white and green indicating lamps.

Fuse.

Three-phase motor.

Limit switch: opens when upper limit of travel is reached.

Limit switch: opens when lower limit of travel is reached.

Limit switch: closes when lower limit of travel is reached.

FIG. 6.—SCHEMATIC DIAGRAM (WITH KEY) OF WITTON HIGH-FREQUENCY FURNACE.

Witton High-Frequency Furnace.

The solution was found to lie in a furnace of the partially-cored type invented and developed by Mr. Victor Stobie and produced by the G.E.C. as the Witton high-frequency induction furnace. In this furnace that portion of the magnetic field not passing through the charge passes through thin laminations of special alloy steel having a conductivity for magnetic flux which is several thousand times that of the air path in furnaces of the coreless type. This alloy steel path "C," Fig. 2, is brought to the nucleus of a core "D," Fig. 2, in a central position below the crucible, "A," and in line with the vertical axis of the inductor coil, "B." The electro-magnetic system furnishes an intensely strong and centrally-situated magnetic field within the crucible containing the charge, and results in obvious and valuable economies. It will be evident that the provision of this ferro-magnetic path or partial coring has the additional effect of reducing the stray magnetic field to an imperceptible amount and has an important influence on the general construction of the furnace. The furnace body is of substantial iron and steel construction which will withstand the rough usage of the workshop, while the massive alloy steel container forms a rigid support for the internal crucible and the inductor coil and for the external body. Since mention has already been made of the use in some coreless furnaces of sheet copper shields in an attempt to prevent overheating of the furnace casing by stray fields, it should perhaps be pointed out here that, since such a field cannot terminate in a core entering the vertical axis of the inductor coil or furnace, the presence of the

stray field must tend towards decreased efficiency.

Construction.

The Witton high-frequency furnace consists essentially of:—(1) A crucible, built up of shaped bricks or made by ramming refractory material into shape in the furnace; (2) a spiral copper inductor coil surrounding the crucible and carrying the high-frequency current; (3) a high-magnetic alloy-steel container which supports the inductor coil and the crucible; and (4) a metal casing surrounding all the above and forming the exterior of the furnace body.

A cross-section of the furnace is given in Fig. 2. This shows diagrammatically the electrical system and illustrates the strength of construction which this system renders possible. The water-cooled inductor coil "B" is insulated and fits against the alloy-steel container "C." No heat from the crucible or current from the inductor coil can reach the container. Actually, the container is earthed, giving adequate protection even were the insulation of the inductor coil to fail, or the molten-metal charge to find its way through such a stoutly-reinforced crucible. The crucible is built either of acid or basic brickwork, or is rammed into shape against the inductor coil. The furnace body "E" is bolted to the alloy-steel container. The strength of the magnetic field within the crucible of the Witton furnace having been increased by the provision of the ferro-magnetic path already referred to, it has been possible to reduce the periodicity of the high-frequency current employed and to increase its voltage. Both these modifications are desirable and have the effect of reducing losses; the one by reducing eddy-current and hysteresis losses and the other by reducing I^2R losses. The power factor of the furnace is also improved owing to the use of a lower periodicity and smaller current and, with improved power factor, less condenser capacity is necessary and smaller inductor, smaller cables, etc., can be employed with proportionately reduced losses in respect of these items.

It is interesting to note the effect which the alloy-steel container and core nucleus of the Witton furnace have on the magnetic-flux distribution within the furnace. This is illustrated diagrammatically in Figs. 3 and 4. It is well known that a current induced in metal by an inductor coil does not, normally, spread itself uniformly across the whole section of the metal. It penetrates only a certain depth from the furnace, the depth depending, among other factors, on the periodicity of the induced current: the lower the periodicity, the greater the penetration. At frequencies used in high-frequency furnaces melting a metal such as steel, the penetration tends to be shallow; a wide crucible of steel scrap within a coreless furnace is heated mainly near the inner diameter of the crucible. The new furnace heats the scrap more uniformly as its central core forces a strong magnetic flux to enter the central portion of the crucible and to distribute itself throughout the charge.

The surface of a bath of molten metal in a high-frequency induction furnace is convex, the level of the centre part of the surface being higher than that of the sides. This is due mainly to the known phenomenon of inter-repulsion between adjacent conductors carrying

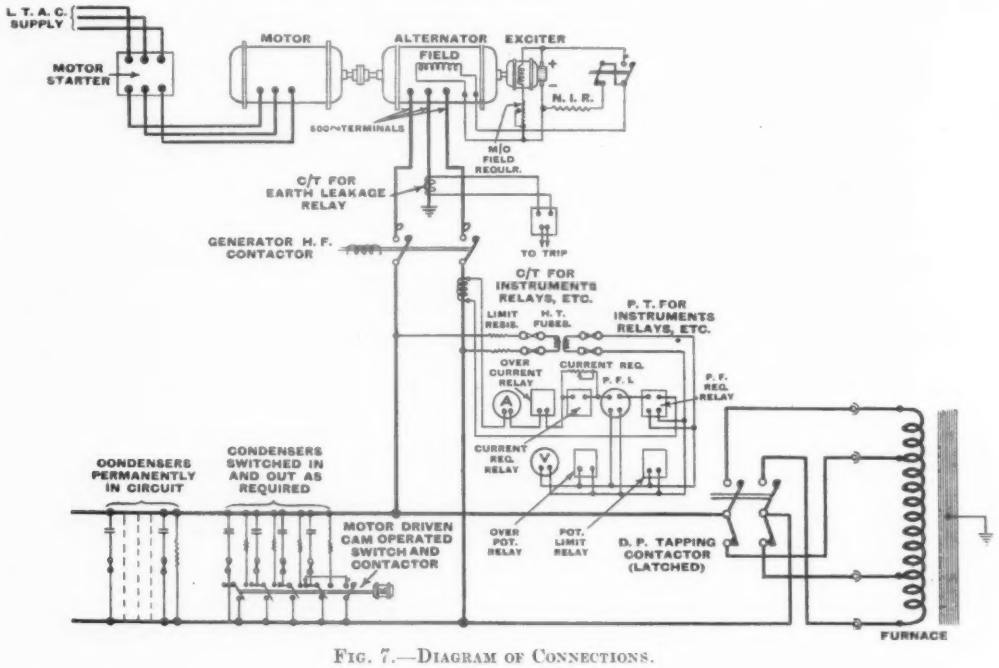


Fig. 7.—Diagram of Connections.

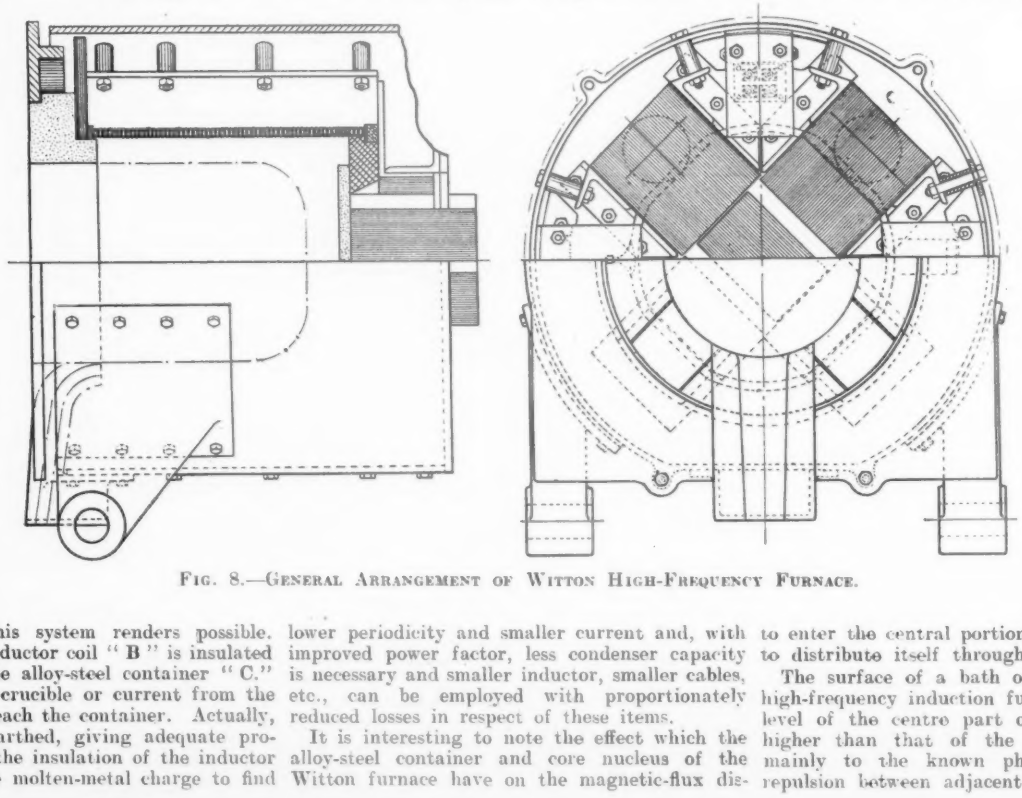


Fig. 8.—General Arrangement of Witton High-Frequency Furnace.

electrical current in opposite directions. The current in the furnace charge travels in the opposite direction to the current in the inductor. Actually, the inter-repulsion is between the opposed magnetic fields of the two currents. It has already been shown that the electro-magnetic system of the particular furnace under discussion ensures an intensely powerful flux which, being centrally placed, repels in a radial outward direction the field of the current it induces in the charge, and tends to push the molten metal up the inner wall of the crucible. By the nature of the total forces, the central axial rise of the metal remains the stronger, but the circumferentially upward force opposes any abnormal central "swell" of the charge. But for this fact, the relatively low periodicity of current which is used on the Witton furnace would cause a greater swell on the surface of the bath than is desirable for metallurgical reasons. Another factor which reduces this "swell" in the partially cored furnace is that the design facilitates the use of a reasonably wide crucible; narrow and deep crucibles tend to increase swell. It will, of course, be apparent that the automatic stirring effect which causes this "swell" is a most desirable feature, as each melt is of uniform composition throughout.

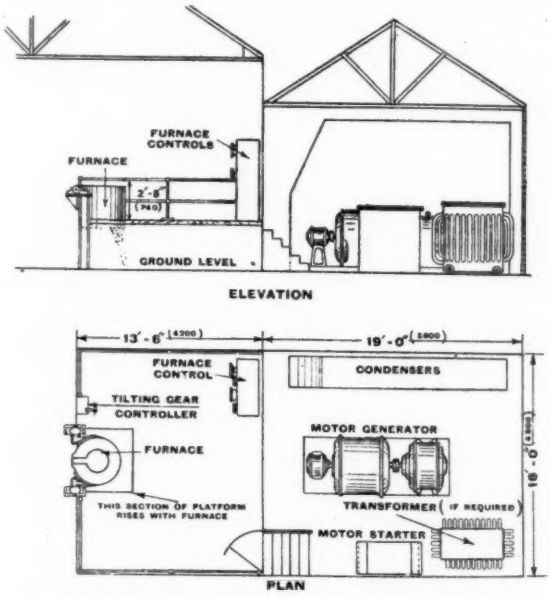


FIG. 9.—TYPICAL LAY-OUT OF COMPLETE ELECTRIC MELTING FURNACE EQUIPMENT.

Complete Melting Installation.

So far, the technical considerations involved in the design of high-frequency furnaces of the coreless and partially cored types, and the effect of providing an alloy-steel path of high conductivity for magnetic flux in furnaces of this type have been discussed. A complete high-frequency electric-melting installation consists essentially of a motor-generator set, condensers, automatic-control gear and the furnace itself.

The Motor-Generator Set.—A motor-driven single-phase alternator is employed, capable of the desired output at a voltage and periodicity which is appropriate to the particular purpose for which the furnace is to be used. The design of the alternator depends on the size of the set. The motor is usually of the three-phase, slipring induction type. These two machines, with the exciter, are mounted on a combination bedplate forming a self-contained unit.

Condensers.—A bank of condensers is provided for power-factor correction so that the maximum capacity of the alternator may be taken at unity power factor.

Automatic-Control Gear.—The automatic-control gear usually consists of a stator-control cubicle, exciter pedestal, liquid starter, automatic and protective relay panel, push-button-control cubicle and power-factor-control gear, together with the necessary multi-core cables required for interconnections between the control panel, relay panel, etc. This equipment includes switchgear for starting the motor-generator set by hand; all other operations are carried out by push-button control from the furnaceman's control panel and by automatic-control gear which provides power-factor correction and maintenance of any desired power on the furnace.

The Furnace.—The furnace is tilted by means of an electric motor operating through spur and bevel gear, the axis of the trunnions being in line with the pouring spout.

Automatic Control Gear.

During the course of a normal run of the furnace, varying conditions in the latter make it necessary continuously to regulate the electrical equipment in order to maintain a constant power input to the furnace whilst maintaining a good power factor on the generator. In this way is the output of the generator kept within the k.v.a. capacity of the unit.

The main object of the automatic gear is so to render the necessary electrical adjustments that the furnaceman can devote his attention to the metallurgical process. Further advantages include a more consistent loading of the plant and a quicker operation of the controls, resulting in an increased output from the furnace.

The general lay-out of the plant is made to suit the existing site and local conditions. The chief considerations governing the lay-out are convenience of operation and economy of floor space. In a typical case, the furnace itself is mounted on the front of the furnace platform with the controller for the tilting motor conveniently near. At the back of the platform the control pillar is mounted against the wall and, nearby, the cooling-water control apparatus, water-flow relay and waste-water sump. Immediately behind all this, in a separate room, well built to keep out dust and dirt, are housed the power unit, the condensers and all the switchgear. Alternatively, the power room may be to the side of the furnace instead of at the back. The motor-generator set and its starter may, if desired, be some distance away from the furnace.

Description of Operation.

The power unit is started from the power room, an indicating lamp on the furnace control board being provided to show that the power unit is ready for service. The cooling water for the furnace coil is then turned on, and the water flow operates the water-flow relay and prepares the equipment for starting. The furnace circuit is switched on to the starting section of the furnace coil by depressing the appropriate push-button on the furnaceman's switchboard.

The generator main contactor is now electrically closed by operating another push-button on the furnaceman's switchboard. Automatically the field contactor closes and the generator becomes excited (field rheostat all in).

The current-regulating relay now takes charge and operates the field rheostat to raise the current to the value desired by the furnaceman according to his prior setting of the power-regulating hand-wheel. The voltage required for this purpose is chosen automatically by the same device.

When the charge is red hot, the full current is maintained on a falling voltage. It is then necessary to put the whole of the furnace coil into circuit. To accomplish this, the main generator contactor is tripped by depressing an appropriately labelled push-button on the furnaceman's switchboard, when the alternator field contactor will also trip and suppress the alternator field. The push-button to change the coil tapping switch is then depressed. The completion of this operation is indicated by lamps on the furnaceman's switchboard. The generator switch is then reclosed, and the current regains the value indicated by the setting of the power-regulating hand-wheel.

At all necessary times a power factor relay automatically operates to switch in or out the condensers necessary to maintain the power factor of the generator circuit at a very high value.

The following protective features are available:—(1) The switchgear is completely interlocked to prevent operating mistakes; (2) failure of the cooling-water supply prevents the generator from being excited, or, if the generator is excited when the water fails, the generator and field contactors open and cut off from the furnace; (3) if for any reason the generator becomes seriously overloaded, the generator and field contactors open and cut off the load; (4) if an earth leakage develops on the high-frequency circuit, the plant shuts down; (5) if a serious over-voltage occurs on the high-frequency circuit, the generator and field contactors open and cut off the load; and (6) if the motor driving the power unit becomes seriously overloaded, the plant shuts down.

In cases 3, 4 and 5, the relays are made to be reset by hand to prevent the plant being restarted from the furnaceman's switchboard.

Industrial Applications.

By far the largest and most important field of application of the high-frequency electric melting furnace is in the iron and steel industry. It also has non-ferrous applications which, though important in themselves, are not nearly so extensive as its uses and potentialities in the ferrous trades. It is, for example, an ideal melting furnace for high-grade nickel-chromium and similar alloys. Its principal uses are melting alloy and carbon-tool steels, stainless iron and steel, and other special alloy steels.

Metallurgical Advantages.—This type of furnace enables steel and other metals to be melted on a commercial scale and under ordinary workshop conditions with a precision which otherwise is only obtainable in the laboratory. A furnace charge can be melted without any possibility of picking up impurities. In fact, there can be no involuntary change in the composition of a charge within the furnace except for that very

(*Continued on page* 358.)

Costing in a Russian Foundry.

By P. Fox-Allin (Associate Editor).

The operation of a costing system for the conception and working of which the men themselves are responsible is a sufficiently striking innovation to be generally interesting. In no country other than Russia would such a system be possible, because there is not elsewhere the unmistakable urge behind and the childlike enthusiasm amongst the workers, the highest testimony of the effectiveness of the Soviet propaganda. It might be said with equal truth that in no other country would such a system be necessary, because in Russia alone, amongst the countries with any pretension to industrialisation, is there such a complete failure of administration and organisation, such a total disregard to the value of labour in relation to the time factor, process costs and overhead charges.

If evidence were wanted to justify this damning indictment, it is furnished by some of the more intelligent of the workmen, who, recognising the wholesale inefficiency of the works in which they are engaged, have on their own initiative instituted a system of costing, with results which have more than justified their enterprise and to demonstrate more graphically than would be possible in any other manner the administrative failure.

Baltic Shipyard Method.

There are several works where a more or less modified system of costing is operative. It will, however, be of most interest if we deal with the system as applied to the foundry of the Leningrad Baltic Shipyard, and outline the working so far as possible in the words of the originator, A. Nikolayev:—

"In the shop there are forty brigades, the brigade in question consisting of a foreman, assistant foreman and nine apprentices. This brigade determined to keep exact account of how much it spends and how much it produces for the State. To begin, in fact, a new stage of Socialist competition and shop brigade work, to use materials rationally and not to waste time, and to eliminate absenteeism; to increase and improve quality, increase production and cut down costs. In an agreement drawn up with the shop manager, the brigade undertook to put in a full day's work, not to allow absenteeism, and to cut down waste by 5 per cent., whilst the administration on their side promised not to hold up the delivery of materials."

Nickolayev stated that "before the establishment of the costing system the work of the brigade justed drifted on anyhow. The production plan was always received late and changed several times after it had been received. Although the brigades were supposed to be in Socialist competition, no account was kept of the shock brigade work which was done. Cost accounts were not located. All the material used in a given quarter was lumped together and recorded as overhead expenses. The materials necessary for work were never ready on time. Such conditions, he stated, killed all desire to work and wrecked all efforts to fulfil the industrial and financial plan."

"During the first month of its operation the brigade were allocated the task of producing 27 tons of castings for the sum of 9,994 rubles 32 kopeks. Each ton required a ton of facing sand, costing 8 rubles 6 kilograms of wire costing 25 kopeks per kilo, 0.5 kilo or tuper vents costing 3 rubles 25 kopeks a kilo, four partitions each costing 25 kopeks, 1 kilogram of kerosene costing 9 kopeks, etc., the total cost of materials for the 27 tons being 386 rubles 21 kopeks. When we considered these items, we at once saw that we could save a great deal on materials and considerably decrease scrap. I may mention that in our shop scrap in the moulding process reached an average of 16 per cent."

"We decided that it should be possible to save about 25 per cent. in the cost of materials. By a correct distribution of the working forces and thus raising the productivity of labour we should be able to save about 700 rubles on our allocation for the month. Books were issued for ordering materials from stores, requisitions being made in duplicate and signed by the brigade leader. On the basis of the requisitions the stores clerk makes out his order for materials in triplicate, once every five days. One copy goes to the accounts office, where the cost is fixed and a record of the materials used kept, the second copy goes to the supply department and the third remains with the stores clerk. An account is taken of stock in hand after the completion of the monthly programme. The shop economist draws up a final account of the cost of production, which, of course, includes materials used and labour costs."

"Under such circumstances not a single spring goes to waste. Everything is being accounted for and we know the exact cost of each detail which before was impossible. When the product is finished there still remains some materials which cannot be used, this is sold back to the shop at 'junk' prices. From the very outset progress was made against stoppages. During the month there were 2.42 per cent. stoppages for which the administration was responsible, in our brigade the percentage was only 1.32. During this first month our brigade fulfilled its quota up to 95.6 per cent., whilst the shop as a whole fulfilled its quota, 70.7 per cent."

"We took 44,447 kilograms of molten metal from the shop; a ton of molten metal costs 74 rubles 62 kopeks. The total cost of the metal used was therefore 3,316 rubles 63 kopeks. Wages amounted to 1,645 rubles, which, plus the average overhead expenses, amounted to 4,376 rubles 10 kopeks; losses due to scrap amounted to 97 rubles 93 kopeks. Thus, our total expenditure amounted to 9,635 rubles 66 kopeks, whilst we turned out products to the value of 9,558 rubles 21 kopeks, this apparent increase in productive costs was really a substantial reduction because we returned to the shop 147 kilograms of useful material."

	Costing brigade.	Entire foundry.
Output in tons	26.3	337.0
Output turned out in percentage	95.6	67.4
Productivity of labour per man-hour	13.09	14.91
Percentage of shock-brigade workers	100.0	35.1
Percentage of waste due to moulders	7.72	14.5
Percentage of stoppages	1.32	2.42
Percentage of absenteeism	1.47	2.42
Percentage of labour turnover	—	3.24

"According to the plan our brigade was to decrease the cost of production 10.5 per cent. during the first quarter, thus bringing the cost of a ton of castings down to 363 rubles 43 kopeks. The cost of production was actually brought down to 328 rubles 43 kopeks, which is 9.4 per cent. below the estimate in plan, the total saving effected being 34 rubles 64 kopeks per ton. During the month there were only 24 hrs. of absenteeism or 1.47 per cent.; this cost us 50 rubles. During the same period the absenteeism for the entire shop was 5.67 per cent., which cost the shop approximately 3,000 rubles. The following tabulated results—which show the working of the costing brigade, compared with the activities of the foundry as a whole—are particularly interesting."

The lower productivity of labour in the brigade is due to the more complicated nature of the castings which they were called upon to produce. The waste is accounted for by the rejection of a casting weighing 2,450 kilograms. In the second month productive costs were reduced by a further 8 per cent., so that the actual saving which was directly due to the costing system amounted to rather more than 20 per cent.

Nikolayev does not hesitate to criticise the administration, for he states the difficulties in carrying out the plan of the brigade were solely due to lack of administration. He states that "by the 27th of the month we had fulfilled our plan in moulding 95 per cent., in casting less than 10 per cent." The matter was that the obligations of the shop administration was not sufficiently concrete. It seemed as if the administration did not want to create the necessary conditions for the work of the brigade to go smoothly.

Nikolayev said: An 8-cylinder pattern was not given us until the 8th instead of the 1st of the month, the box on the 17th instead of the 10th and the second box on the 15th instead of the 10th. The second box had to be remade no less than five times. With such delivery of materials it was only possible to fulfil our plan with great efforts."

A great deal more might be written on this subject, but sufficient has been said to illustrate the undoubted enthusiasm of the workers on the one hand and the hopeless failure in organisation and administration on the other.

The Witton High-Frequency Electric Melting Furnace.

(*Continued from page* 357.)

slight modification which is due mainly to degasification of the charge. The product is identical in composition with the sum of the materials charged into the furnace. Metal so melted cannot take up sulphur as it does in the coke- or producer-gas fired furnace. High chromium and other alloys which have a strong affinity for carbon are melted without carbon increment. Furthermore, steel melted in the Witton high-frequency furnace has been found by microscopic analysis to be practically free from non-metallic oxides or slag inclusion. Another important feature is that of temperature control; the casting temperature of a charge can be adjusted with extraordinary precision. It is just as easy to work to any predetermined temperature on a large furnace working under ordinary production conditions as to do so on a small furnace in the laboratory.

A further feature which is of the greatest metallurgical importance, and which is peculiar to the high-frequency electric melting furnace, is the automatic-stirring action which is caused by electro-dynamic forces within the molten charge. This ensures a uniformity of composition throughout each charge, which is not possible in any other type of furnace. An alloy, such as high-speed steel, the constituent materials of which vary considerably in specific gravity, is melted under conditions which do not permit of any variation in composition from top to bottom of an ingot, nor between any two ingots from the same charge.

Economic Considerations.

Normal experience leads one to expect benefits such as those which have just been described to be accompanied by increased costs of production. In this instance the reverse is the case.

Obviously, when considering cost of production in an electric furnace, the first item to be considered is that of current consumption. The current consumption of the high-frequency furnace described is lower than that of an arc-type

(*Concluded on page* 360.)

This Week's News in Brief.

Trade Talk.

THE L.M.S. RAILWAY have completed at their works at Derby a heavy fuel-oil locomotive. It has been designed for shunting purposes, and has been constructed to ascertain whether economies can be secured by the use of heavy fuel oil for railway traction.

THE NEW CRUISER, "Leander," the first 6-in. gun cruiser built since the Washington Conference, has carried out trials on the Clyde. The "Leander" was built at Devonport Dockyard, and her geared turbines, developing 72,000 shaft h.p., were supplied by Vickers-Armstrong, Limited, Barrow-in-Furness.

THE SINGLE-SCREW passenger and cargo steamer "Hunan," built by Scotts' Shipbuilding & Engineering Company, Limited, Greenock, for the China Navigation Company, Limited, London, has completed successful trials on the Firth of Clyde. This is the 80th vessel built by Messrs. Scott for the China Navigation Company since 1876.

AS A RESULT of the audit of the employers' books for September and October, Sir John M. MacLeod, Bat.C.A., Glasgow, has intimated to the joint secretaries of the Manufactured Iron Trade Conciliation and Arbitration Board that the net selling price was £9 16s. 10d., which means that the basis rates of the wages of the workmen will be reduced 2½ per cent.

MESSRS. WILLIAM DENNY & BROS., LIMITED, Dumbarton, launched the new steamer, "Brighton," built for the Southern Railway Company's cross-Channel services after a postponement on account of heavy weather. The naming ceremony was performed the previous day, and at a luncheon following Mr. Maurice Denny stated that he expected two more orders in the course of a week or two.

A VESSEL SPECIALLY CONSTRUCTED for service in the Firth of Forth as a lightship was launched this week by Messrs. A. & J. Inglis, Limited, Pointhouse Shipyard, Glasgow. Dalzo weather-resisting steel was used in the vessel's construction in order to increase the durability, as the craft will have to withstand the seas on the East Coast of Scotland. She was named "North Carr," and is destined for the service of the Northern Lighthouses at North Carr.

DURING THE PAST few weeks a decided improvement has been apparent in the Dundee Engineering and allied trades. Blackness Foundry, one of the largest establishments on the East Coast of Scotland, has been working on a number of large orders from the Continent, and many men who have been idle for a considerable time have been re-engaged. Work is now proceeding on 46½ hours per week basis, and the outlook for the future is very encouraging.

AN ENJOYABLE social evening was held in the Miners' Welfare Institute of Shotts Iron Company, Limited, recently by a party of officials and workmen representing the works department and the collieries of the Shotts Iron Company. Matches were arranged at bowls, billiards and whist, and all were keenly contested. The party were entertained to tea by Mr. A. S. Murdoch, chief engineer to the company. Mr. W. Spalding, who presided, expressed the hope that the works department would continue to take a lively interest in welfare.

A REVIVAL IN SHIPPING was forecast by Mr. J. B. Hutchison, Greenock, President of the Shipbuilders' Federation, at the annual dinner of the Greenock Ardgowan Club. Mr. Hutchison said he thought the worst days of depression were now behind them. There were indications, although small, of more genuine inquiries for new ships as against the usual price-testing inquiries. If his expectations were realised and 1933 brought much-needed shipbuilding and ship-repairing orders, he could assure them that Greenock and Port Glasgow would be very much in the forefront when orders were being booked. The lower reaches of the Clyde had always been first to secure work when a revival of trade set in.

THE DEATH OCCURRED, at Little Bispham, near Blackpool, of Mr. George Ryder, who was connected with the firm of Ryder Bros., ironfounders, of Bark Street, Bolton, for over sixty years. A son, Mr. Norman Ryder, is now managing director of the business.

Obituary.

MR. A. C. J. CHARLIER, who was well known in the Sheffield steel and metal industries, has died at Westcliff-on-Sea.

MR. JOHN HERRING, principal of the firm of John Herring & Company, iron, steel and metal merchants, West Hartlepool, died on Saturday, November 26, at the age of 64.

THE DEATH OCCURRED, at his home in Glasgow, on December 1, of Mr. Thomas Richard Evans, late manager of Messrs. Macfarlane Strang & Company, Limited, Lochburn Ironworks, Maryhill, Glasgow. He was 82 years of age.

THE DEATH OCCURRED, on December 2, of Mr. William Campbell Smith, of the firm of Messrs. George Paul & Company, Limited, Duncarron Foundry, Denny. Deceased was 27 years of age and a grandson of Mr. George B. Paul, ironfounder, Denny, at whose residence he passed away after a brief illness due to pneumonia. Mr. Smith was a young man of much promise, and from whom much was expected in the future in the development of the foundry.

THE DEATH OCCURRED, at his home in Glasgow, on November 26, of Mr. William Henry Herdsman, analytical and metallurgical chemist, Glasgow. Mr. Herdsman was manager for the firm of Edward Riley, consulting metallurgists and analysts, London, for many years, and came to Glasgow to practice on his own behalf in 1909 after the death of Mr. Edward Riley. He was well known in connection with metalliferous mining, and travelled in many countries on behalf of clients.

SIR JAMES MARR, BT., of Roker, Sunderland, died on November 24. Sir James, who was 78 years of age, spent the whole of his life on Wearside, and was associated with practically all the shipbuilding and ship-repairing undertakings in the district. At the age of 14 he entered the yard of Messrs. Oswald & Company, Pallion, and eight years afterwards joined Messrs. J. L. Thompson & Company, shipbuilders. In 1882 he became general manager of the firm, and five years afterwards he and other members of the firm took over a forge at Sunderland, now known as the Sunderland Forge & Engineering Company, Limited. Other firms of which Sir James was a director were Messrs. Sir James Laing & Sons, shipbuilders; and Messrs. T. W. Greenwell & Sons, Limited, shiprepairers, and he was also a member of the Wear Commission. He was for several years chairman of the Wear Shipbuilders' Association, and was a county magistrate.

WE REGRET TO RECORD the death of Mr. Robert F. W. R. Nelson, chairman and managing director of Messrs. Hurst, Nelson & Company, Limited, Motherwell, which took place in a Glasgow nursing home on December 1. Mr. Nelson had been suffering from heart trouble and entered the home about a fortnight ago, but his death was not expected. He was born in Stirling in 1888, and educated at Trinity College, Glenalmond, and subsequently entered the firm of Hurst, Nelson & Company, where his father, the late Andrew S. Nelson, was managing director. He showed great keenness in his business activities, and on the death of his father in 1913 he was appointed in his place. Mr. Nelson showed true judgment and an appreciation of the necessity of adopting up-to-date methods and appliances. During normal times the rolling-stock and plant works employ about 800 men. Mr. Nelson was recognised as an industrial leader, and was as well known in London business circles as in Scotland. During his career he was responsible for many developments in the business, and some time ago was appointed chairman of the company. He was also chairman of the auxiliary concern, Wagon Repairs, Limited, Birmingham. He was elected a Coalition Unionist at the coupon election in 1918, but resigned from Parliament for health reasons in 1922.

MANY ASSOCIATED WITH THE Falkirk foundry trade have learnt with regret of the death of Mr. Gilbert MacIntosh, of the Burnbank Foundry Company, Limited, which took place at his residence in Stirling on November 26. Mr. MacIntosh had been connected with the light-castings industry practically all his life, and was a well-known and extremely popular personality. He had enjoyed excellent health until about a year ago, when he developed an illness which necessitated an operation in the early part of this year, and this was followed by two others later. He was 65 years of age, a native of Falkirk, and began life as a boy in the Falkirk Post Office, a post which he occupied for only a short time before obtaining a post in the office of Grahamston Iron Company, Limited, and entering upon a foundry career. After six years he took up a position with the firm of Young & Marten, Limited, London. Later he returned to Scotland and became associated with the now extinct Forthbank Foundry Company, Bo'ness. He again went to London as agent for the Callendar Iron Company, Limited, Falkirk, for a few years before again joining the old firm of Young & Marten as chief of the castings department. Once more he returned to Scotland, and served for some years with Falkirk Iron Company, and later became commercial manager to Carron Company, a position he filled for a number of years. Soon after the end of the war Mr. MacIntosh severed his connection with Carron Company, and became associated with Burnbank Foundry Company, Limited, Falkirk, and continued in this position up to the time of his death.

Personal.

MR. H. CRAWSHAW has changed his address as from December 1, 1932, to La Montagne, Hyon-Ciply (Mons), Belgium.

SIR SAMUEL INSTONE has been appointed a Lieutenant of the City of London on the nomination of Sir Maurice Jenks, the ex-Lord Mayor.

MR. J. P. JARDINE has just completed 50 years' service with the Shotts Iron & Coal Company, Limited, Loanhead, Lanarkshire. He is still continuing.

MR. RICHARD BANNER, who worked all his life until retirement in the works of Monks, Hall & Company, Limited, has with Mrs. Banner celebrated his golden wedding.

MR. F. W. FELL CLARK, formerly chairman of the Coventry Chain Company, Limited, has resigned from the board of the Renold & Coventry Chain Company, Limited.

THE TELEPHONE NUMBER of Mr. Vincent Delport's home address at Petrouchka, Kenton Gardens, Kenton, Middlesex, has been changed from Harrow 0338 to Wordsworth 2014.

MR. AND MRS. THOMAS DURKIN, of Dumbarton, have celebrated their golden wedding. Mr. Durkin was an employee of Dennystown Forge for over 30 years prior to his retirement. He was local secretary of the Ironmoulders' Society.

MR. A. J. GRANT, of Messrs. Thos. Firth & John Brown, Limited, President of the National Federation of Iron and Steel Manufacturers, has been elected a member of the Executive Council of the National Union of Manufacturers.

MR. T. FRANKLIN SIBLY, Vice-Chancellor of the University of Reading, has been appointed by the Lord President of the Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

MR. H. L. MUNNOCH is retiring after 51 years' service at the Skinningrove Iron and Steel Works, and last week he received a presentation from works officials and others. Mr. Munnoch commenced as junior clerk, and rose to the position of secretary of the firm. During the ten years that the works were leased by Messrs. Pease & Partners, Limited, he occupied the post of chief accountant.

MR. W. LOMAS, chairman of the directors of Messrs. J. & J. Dyson, Limited, firebrick manufacturers, of Stannington, near Sheffield, has been the recipient of many well-deserved congratulations on the attainment of his 90th birthday. He still attends business every day, and to celebrate his birthday he presented all members of the staff and employees with a concrete souvenir of his appreciation of their services.

Wills.

THOMPSON, E. H., of Sunderland, shipbuilder £44,789

DAVY, STEPHEN, of Chapeltown, Sheffield, for 20 years manager of the blast-furnaces department at the Thorncliffe Ironworks of Messrs. Newton, Chambers & Co., Limited £1,079

Raw Material Markets.

Although hampered by the cautious buying policy of consumers, the iron and steel markets continue to show more movement, the volume of inquiries increasing weekly. Trade in pig-iron has been steady, although mainly confined to small parcels for immediate delivery. Business in finished and semi-finished steel has also been restricted, but the home works have taken nearly all of the business available.

Pig-Iron.

MIDDLESBROUGH. — Local consumers have recently come into the market, in some cases for supplies over the next month or two, and the position is considerably strengthened. Stocks of unsold iron, however, are still considerable, and it is unlikely that any increase in production will be made before the end of the year. A limited export business has been done at prices slightly below those quoted locally, which are also considerably reduced to Scottish consumers. Local foundries pay the full zone prices, which are :—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

Although the output of East Coast hematite is considerably increased, the demand has risen accordingly, and the makers are rather more optimistic regarding the prospects for the next quarter. Mixed numbers remain unchanged, however, at 59s. per ton. With regard to the West Coast hematite trade, two furnaces have just been re-lit at Barrow, there being a heavy local demand to satisfy, in addition to a steady outside consumption. Bessemer mixed numbers are firmly maintained at 66s. per ton at works.

LANCASHIRE. — Sales of pig-iron are maintained on a steady basis. Forward orders of any consequence are still very scarce, few consuming firms being fully confident of their winter programme. Foundries manufacturing light castings and speciality products report brighter trade prospects. Prices remain generally steady, current offers for delivery to users in the Manchester zone being on the basis of 67s. per ton for Derbyshire, Staffordshire and North-East Coast brands of No. 3 iron, 65s. 6d. for Northamptonshire, 62s. for Derbyshire forge, from 83s. to 84s. for Scottish No. 3, about 81s. for West Coast hematite, and about 76s. for East Coast hematite.

MIDLANDS.—More forward contracting has been witnessed during the past few days, in some cases involving considerable tonnages. Speaking generally, however, the position of the foundries has not improved sufficiently to warrant any heavy forward demand for pig-iron. The current rates are 62s. 6d. for Northants No. 3, and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations. Cleveland iron remains at 66s. per ton.

SCOTLAND.—Only intermittent working is possible at most of the foundries, and the demand for iron is very limited, even the light-castings trade remaining generally depressed. The export trade continues to contract. Scottish pig-iron is still quoted at 67s. 6d. for No. 3 foundry f.o.t. furnaces, with 2s. 6d. extra for No. 1. Middlesbrough iron is still in poor request, the special quotation for Scotland still ruling, namely, 55s. f.o.t. Falkirk for No. 3 foundry. Northamptonshire foundry iron is being offered at about 54s. f.o.t. Falkirk.

Steel.

The quiet conditions which generally rule before Christmas have developed and have been intensified by the inclination shown in most markets to await the outcome of the American debt negotiations. In the semi-finished steel department the demand from the British works is gradually increasing, and little is heard of purchases of Continental material by home users. There are still stocks of foreign material in the country, but these are being steadily reduced. Business in finished steel is more active in the home department than for export, but recently there has been a fair amount of inquiry from overseas markets. Only a small proportion of this has developed into business, but it would appear that a considerable tonnage of orders is being withheld until international affairs become more settled.

Coke.

Foundry coke is still very difficult to sell, in spite of the fact that the makers are willing to contract well forward at the rates now ruling, which are as follow:—Best Durham foundry coke, 36s. 6d. to 38s. per ton; other grades 35s. and upwards; Welsh coke, 30s. to 45s.; delivered Birmingham and district.

Scrap.

Prices of scrap-iron are unchanged on the Cleveland market, but supplies are stated to be getting scarcer. The demand has also improved in South Wales, where prices are firm. In Scotland, ordinary cast iron is firm at 39s., and machinery quality at 44s. There is a fear that scrap prices will be increased at the beginning of the New Year. Similar conditions rule in the Midlands, where sellers are not anxious to commit themselves far ahead. There is a fairly good demand for material, heavy machinery quality being at 42s. 6d. to 45s. and good heavy at 40s.

Metals.

Copper.—The course of the market has been fairly steady during the past week, prices weakening slightly in accordance with a rise in the sterling exchange. Consumers have been replenishing their stocks to some extent, having been off the market for some time. The producers' conference in New York has made little progress as yet, and it is much doubted whether they will be able to come to any agreement of value. It is unlikely that the low-cost Empire producers will jeopardise their future with further restriction schemes, especially so in view of the pending British tariff on foreign metal that virtually grants them an exclusive market for their output.

Closing quotations :—

Cash.—Thursday, £31 10s. to £31 11s. 3d.; Friday, £31 12s. 6d. to £31 13s. 9d.; Monday, £31 to £31 1s. 3d.; Tuesday, £30 15s. to £30 16s. 3d.; Wednesday, £30 15s. to £30 16s. 3d.

Three Months.—Thursday, £31 16s. 3d. to £31 17s. 6d.; Friday, £32 to £32 1s. 3d.; Monday, £31 7s. 6d. to £31 8s. 9d.; Tuesday, £31 1s. 3d. to £31 2s. 6d.; Wednesday, £31 2s. 6d. to £31 3s. 9d.

Tin.—The general demand for this metal is not very good, the chief call being from the South Wales tinplate mills, which continue to show satisfactory activity. The November statistics showed little decline in visible supplies, and the effect of the restriction measures has been disappointingly limited. The "pools" who have been supporting the market by buying up any loose supplies are likely to find themselves permanently saddled with large stocks.

Official closing prices :—

Cash.—Thursday, £151 10s. to £151 12s. 6d.; Friday, £151 15s. to £151 17s. 6d.; Monday, £150 15s. to £151; Tuesday, £151 17s. 6d. to £152; Wednesday, £151 12s. 6d. to £151 15s.

Three Months.—Thursday, £152 17s. 6d. to £153; Friday, £153 2s. 6d. to £153 5s.; Monday, £151 17s. 6d. to £152; Tuesday, £152 10s. to £152 12s. 6d.; Wednesday, £152 12s. 6d. to £152 15s.

Spelter.—Trade with consumers has narrowed slightly, and the recovery in sterling has also helped to weaken prices, but the producers are not pressing sales. The statistical position is reported to be still improving, there being a gradual decline in stocks of unsold metal. There cannot, however, be any considerable recovery in the market until the galvanising and brass industries show more activity.

Daily fluctuations :—

Ordinary.—Thursday, £15 1s. 3d.; Friday, £15 6s. 3d.; Monday, £15 3s. 9d.; Tuesday, £15 2s. 6d.; Wednesday, £15 2s. 6d.

Lead.—The industrial demand for lead remains limited, and only the restraint exercised by the producers is supporting the market. The relations between supply and demand are almost stationary, and the course of the market seems largely determined by the international financial situation.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 15s.; Friday, £11 18s. 9d.; Monday, £11 8s. 9d.; Tuesday, £11 6s. 3d.; Wednesday, £11 6s. 3d.

The Witton High-Frequency Electric Melting Furnace.

(*Concluded from page* 358.)

furnace. It is also lower than that of other high-frequency furnaces for reasons given in the early part of the article. Comparative figures regarding current consumptions are apt to be misleading in an article of this kind because it is impossible to ensure that operating conditions are identical in any two cases which may be chosen for the purpose of comparison. However, as an indication of the current consumption, a run of nickel-chromium-molybdenum stainless steel in a furnace having a nominal capacity of 5 cwts. per charge might be cited. The current consumption for the run worked out at 574 units per ton. Plain carbon steel has been melted from cold to pouring temperature with a current consumption as low as 485 units per ton. This latter figure is not put forward necessarily as a basis for routine commercial calculations, but rather as an indication of the efficiency and economy of the particular furnace under discussion. This feature of low-current consumption is, of course, accounted for by the fact that the heat is generated within the charge itself and is not communicated to it from without. Actually, the metal is hotter than the crucible in which it is contained.

Mention of current consumption in connection with the melting of steel will immediately bring to the mind of the practical steelmaker the question of electrode consumption. This is not an inconsiderable item in the cost of operating arc furnaces, but is entirely absent from the cost sheet of a high-frequency furnace.

Labour costs are reduced to a minimum; little supervision being required other than for charging and pouring. The automatic-control system which has already been described is an important factor in this respect.

Maintenance costs are low. The motor generator, like all modern rotary-electrical machinery, has a very long life. The remainder of the installation, with the exception of the furnace itself, is of standard construction and suffers very little depreciation. So far as the furnace is concerned, the only part which needs replacing periodically is the built-in crucible, the life of which depends upon the steel or alloy melted in it. Its replacement is a simple and inexpensive matter.

Two other factors which are of economic importance should, perhaps, be mentioned. The first is that the feature of rapid melting renders a Witton high-frequency furnace of small unit capacity cable of a comparatively large output. The second is that the furnace can be used intermittently if desired without incurring the penalty of considerably increased running costs.

Manganese in Ecuador.—The deposits of manganese ore discovered about two or three years ago are situated about four and a-half miles from Passaje, El Oro Province, Ecuador, and are estimated to contain fully 120 million tons of ore. A number of boreholes have been sunk to a depth of 28 ft. without reaching the bottom of the ore body. A sample of the general run of ore analysed in London showed Mn, 54.65 per cent.; SiO_2, 0.61 per cent.; P, 0.08 per cent.; S, 2.41 per cent.; Fe_4, 1.52 per cent. A narrow-gauge railway connects Passaje with Puerto Bolivar, on the coast, where 2,000-ton steamers can be accommodated. In view of the somewhat unfavourable geographical position of the deposits and the present depression in the manganese ore market, no attempts have hitherto been made to undertake a thorough investigation of the properties, or to exploit them.

XUM

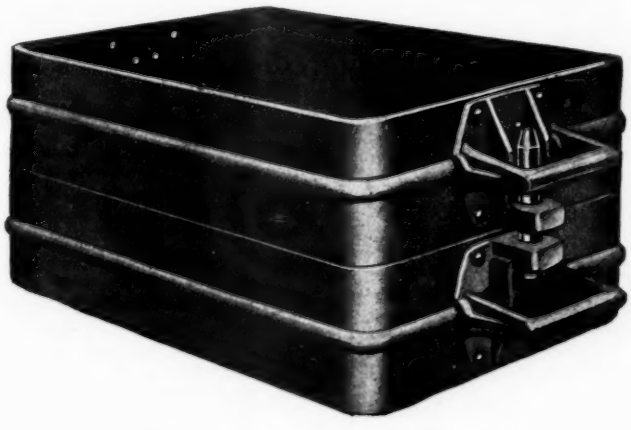
Service Sterling

SOLID RIBBED ROLLED STEEL MOULDING BOXES

Whatever in the future may be the varying fortunes of Sterling Currency on the world's exchanges, foundrymen can rest assured there will be no fluctuation in the value of Sterling Moulding Boxes.

If you stick to Sterling Boxes your moulders will do more work and far better work with less effort; they will produce more accurate castings; you will save money on your fettling costs and more than halve your box maintenance costs—indeed there will be greater efficiency and economy all round. We stand by this statement and will gladly prove it.

Sterling moulding boxes are produced in England's largest Foundry Equipment Works and offer you the nearest approach to perfection that science and skill have yet achieved at a price no more expensive than for ordinary boxes.



Wherever castings are made STERLING BOXES will help to make them BETTER and CHEAPER

STERLING FOUNDRY SPECIALTIES LIMITED. BEDFORD

London Office:— 13, Victoria Street, S.W.1.

Agents at:— MANCHESTER. GLASGOW. NEWCASTLE-ON-TYNE.

TELEGRAMS: "STERFLASK, BEDFORD" TELEPHONE. 3345 BEDFORD.

CODE: WESTERN UNION

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	30	15	0
Three months	31	2	6
Electrolytic	36	0	0
Tough	32	15	0
Best selected	33	5	0
Sheets	65	0	0
India	45	10	0
Wire bars	36	10	0
Do., Jan.	36	10	0
Do., Feb.	36	10	0
Ingot bars	36	10	0
H.C. wire rods	39	10	0
Off. av. cash, October	31	18	7 1/32
Do., 3 mths., October	32	1	8 3/32
Do., Sttlmnt., October	31	18	8 1/32
Do., Electro, October	36	10	11 3/32
Do., B.S., October	34	15	0
Do., wire bars, October	36	18	1 1/2
Solid drawn tubes			10d.
Brazed tubes			10 1/2d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8 1/2d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	8d.
Wire	7 1/2d.
Rolled metal	7 1/2d.
Yellow metal rods	4 1/2d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 1/2d.

TIN.

	£	s.	d.
Standard cash	151	12	6
Three months	152	12	6
English	152	5	0
Bars	155	15	0
Straits	157	0	0
Australian	155	17	6
Eastern	156	5	0
Banca	158	17	6
Off. av. cash, October	151	7	6
Do., 3 mths., October	152	4	10 1/2
Do., Sttlmt., October	151	7	7 1/2

SPELTER.

	£	s.	d.
Ordinary	15	2	6
Remelted	14	10	0
Hard	12	15	0
Electro 99.9	17	10	0
English	16	2	6
India	14	5	0
Zinc dust	22	0	0
Zinc ashes	2	15	0
Off. aver., October	15	0	1 1/16
Aver. spot, October	14	17	4 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	11	6	3
Empire	11	12	6
English	13	0	0
Off. average, October	12	1	3 5/16
Average spot, October	11	19	2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	24	5	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates			—

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to	42	10	0
Chinese				26	15	0
Crude				19	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	8	0	0
45/50%	13	15	0
75%	19	10	0
Ferro-vanadium—			
35/50%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free of Mo.	6/3 per lb.		
Ferro-titanium—			
23/25% carbon-free	10d. lb.		
Ferro-phosphorus, 20/25%	£20	0	0
Ferro-tungsten—			
80/85%	1/7½ lb.		
Tungsten metal powder—			
98/99%	1/10½ lb.		
Ferro-chrome—			
2/4% car.	£32	17	6
4/6% car.	£25	0	0
6/8% car.	£24	2	6
8/10% car.	£23	5	0
Ferro-chrome—			
Max. 2% car.	£36	0	0
Max. 1% car.	£40	2	6
Max. 0.70% car.	£43	12	6
70% carbon-free	1/- lb.		
Nickel—99.5/100%	£260 to £265		
"F" nickel shot	£234	0	0
Ferro-cobalt	7/9 lb.		
Aluminium 98/99%	£100	0	0
Metallic chromium—			
96/98%	2/9 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11 5 0		
76/80% packed	£11 15 0 to £12 5 0		
76/80% export (nom.)	£9 15 0		
Metallic manganese—			
94/96% carbon-free	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ½ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	1	18	0 to	2	0	0
Bundled steel and shrngs.	1	15	0 to	1	19	0
Mixed iron and steel	1	12	6 to	1	17	0
Heavy cast iron	2	0	0 to	2	2	0
Good machinery	2	5	0 to	2	7	6
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	8	6
Cast-iron borings				1	3	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	1	17	6 to	2	0	0
Midlands—						
Light cast-iron scrap				1	15	6
Heavy wrought iron				2	2	6
Steel turnings, f.o.r.				1	0	0
Scotland—						
Heavy steel				1	15	0
Ordinary cast iron				1	19	0
Engineers' turnings				1	8	6
Cast-iron borings				1	10	0
Wrought-iron piling				1	19	0
Heavy machinery				2	4	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	0	0
Lead (less usual draft)	10	10	0
Tea lead	9	0	0
Zinc	8	10	0
New aluminium cuttings	72	0	0
Braziery copper	21	0	0
Gunmetal	20	0	0
Hollow pewter	82	0	0
Shaped black pewter	65	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
„ at Falkirk	55/-
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	61/-
„ No. 3 fdry.	66/-
Northants forge	57/6
„ fdry. No. 3	62/6
„ fdry. No. 1	65/6
Derbyshire forge	61/-
fdry. No. 3	66/-
„ fdry. No. 1	69/-
„ basic	—
Scotland—	
Foundry No. 1	70/-
„ No. 3	67/6
Hem. M/Nos. d/d	67/6
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/- to 84/-
Clyde, No. 3	83/- to 84/-
Monkland, No. 3	83/- to 84/-
Summerlee, No. 3	83/- to 84/-
Eglinton, No. 3	83/- to 84/-
Gartsherrie, No. 3	83/- to 84/-
Shotts, No. 3	83/- to 84/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	15	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				13	0	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	7	6 to	9	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 15 0	& up.		
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 to	10	10	0
Black sheets, 24g. (10-t. lots)	9	5	0			
Galv. cor. shts. „				11	5	0
Galv. flat shts. „				11	15	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	4	17	6 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16½d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.59
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.09
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.85
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	12/- to 12/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/9 to 16/3
„	28×20 „	31/6 to 32/6
„	20×10 „	22/7½ to 23/-
„	18¾×14 „	16/4½ to 16/7½
C.W.	20×14 „	13/9 to 14/3
„	28×20 „	27/9 to 28/-
„	20×10 „	—
„	18¾×14 „	—

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	10	0 to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	5	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Dec.	1 ..	31	10	0	dec.	13/9
,,	2 ..	31	12	6	inc.	2/6
,,	5 ..	31	0	0	dec.	12/6
,,	6 ..	30	15	0	,,	5/-
,,	7 ..	30	15	0	No change	

Electrolytic Copper.

		£	s.	d.		
Dec.	1 ..	36	15	0	dec.	5/-
,,	2 ..	36	10	0	,,	5/-
,,	5 ..	36	10	0	No change	
,,	6 ..	36	0	0	dec.	10/-
,,	7 ..	36	0	0	No change	

Standard Tin (cash).

		£	s.	d.		
Dec.	1 ..	151	10	0	dec.	5/-
,,	2 ..	151	15	0	inc.	5/-
,,	5 ..	150	15	0	dec.	20/-
,,	6 ..	151	17	6	inc.	22/6
,,	7 ..	151	12	6	dec.	5/-

Tin (English ingots).

		£	s.	d.		
Dec.	1 ..	152	0	0	dec.	10/-
,,	2 ..	152	5	0	inc.	5/-
,,	5 ..	151	5	0	dec.	20/-
,,	6 ..	152	10	0	inc.	15/-
,,	7 ..	152	5	0	dec.	5/-

Spelter (ordinary).

		£	s.	d.		
Dec.	1 ..	15	1	3	dec.	1/3
,,	2 ..	15	6	3	inc.	5/-
,,	5 ..	15	3	9	dec.	2/6
,,	6 ..	15	2	6	,,	1/3
,,	7 ..	15	2	6	No change	

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Dec.	1 ..	17	10	0	inc.	5/-
,,	2 ..	17	15	0	,,	5/-
,,	5 ..	17	10	0	dec.	5/-
,,	6 ..	17	10	0	No change	
,,	7 ..	17	10	0	,, ,,	

Zinc Sheets (English).

		£	s.	d.		
Dec.	1 ..	24	10	0	No change	
,,	2 ..	24	10	0	,,	,,
,,	5 ..	24	10	0	,,	,,
,,	6 ..	24	10	0	,,	,,
,,	7 ..	24	10	0	,,	,,

Lead (English).

		£	s.	d.		
Dec.	1 ..	13	5	0	dec.	5/-
,,	2 ..	13	10	0	inc.	5/-
,,	5 ..	13	0	0	dec.	10/-
,,	6 ..	13	0	0	No change	
,,	7 ..	13	0	0	,,	,,

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	47 2	48 5	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	82 6	81 6	81 6	83 6	83 6	83 6	83 7
1932	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	—	—

* No prices available.

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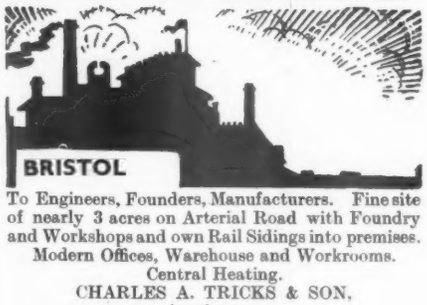

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